

DRAFT
FOR PUBLIC COMMENT

**Low-Level Radioactive Waste
Management Plan**

**Volume III
Surveying Radioactive Materials Users
in the Commonwealth**

GOVERNMENT DOCUMENTS
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Low-Level Radioactive Waste Management Plan

Volume III

Surveying Radioactive Materials Users in the Commonwealth

January 1993

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Notes

This draft Low-Level Radioactive Waste Management Plan is contained in four volumes. While certain terms used in VOLUME iii are defined, all abbreviations, acronyms, and definitions are listed in a separate section following the Table of Contents and Lists of Tables and Figures in VOLUME ii.

Mention of a commercial product or firm does not constitute an endorsement by the Low-Level Radioactive Waste Management Board or the author of this draft Management Plan.

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Volume III: Surveying Radioactive Materials Users in the Commonwealth

1.1 Introduction

For several decades, Massachusetts citizens have shown a keen interest in issues relating to radiation and radioactivity. Many of the residents of communities abutting the two nuclear-powered electric generating plants in Plymouth and Rowe have been especially concerned about the operational activities of those facilities; persons residing near other locations where radioactive materials are used are eager to understand the relationship of those uses to their daily lives.

Most citizens are not familiar with the numerous applications of radioactive materials in Massachusetts; many confuse the differences between "hazardous" waste, and "radioactive" waste. All too frequently, there is misunderstanding about what wastes are categorized as "low-level radioactive waste" (LLW), and what wastes are categorized as "high-level radioactive waste" (HLW).¹

Chapter 3 of VOLUME II of this LLW Management Plan discusses the issues of radiation, radioactivity, waste types and health effects. It also describes the vast assortment of characteristics and wide

¹ Both "hazardous" wastes and "radioactive" wastes are "hazardous." The terms are defined by federal and state laws, and years of study and regulatory controls, and therefore have distinct meanings. "Hazardous waste" is toxic, chemical waste, which, because of its quantity, concentration, or physical, chemical, or infectious characteristics, may cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness, or may pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of or otherwise managed. "Radioactive waste" is waste that is contaminated by radioactive materials. Because doses of radiation can change the chemical structure of living tissue or other matter, radioactive wastes, like toxic chemical "hazardous" wastes, are a concern to public health and the environment if improperly used, treated, stored, transported, or disposed of.

"Low-level radioactive waste" (LLW) is one of several categories of "radioactive" wastes. It is defined by federal and state law by a series of exclusions. For example, LLW is neither high-level waste, nor spent nuclear fuel, nor certain other radioactive material, as determined by the federal government. LLW is contaminated with low concentrations of radioactive materials. In contrast, "high-level waste" and "spent nuclear fuel" contains much higher concentrations of both short and long half-life radioactive material. "High-level waste" (HLW) is defined as the highly radioactive material which results from the reprocessing of spent nuclear fuel; "spent nuclear fuel" is defined as the fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing.

Other definitions can be found in the section titled "Abbreviations, Acronyms, and Definitions: at the beginning of Volume II. A further explanation of the different radioactive wastes can be found in Chapter 4 of Volume II.

variety of waste streams which comprise LLW. Some combinations of these characteristics may cause some LLW to be of relatively small concern from health and environmental perspectives. Other mixtures of attributes may be of substantial concern and may require short- or long-term management strategies.

Because the management (i.e., the storage, packaging, treatment, transportation, or disposal) of LLW is becoming a responsibility of state government, in addition to the authority already exercised by the federal government, the Commonwealth of Massachusetts must have a system to provide detailed information on LLW characteristics in order to make the necessary and appropriate management decisions. Surveys have been one important tool used to collect LLW data and aid in the policy-making process.

In the Commonwealth, the survey acts as a data acquisition tool that is an integral part of the "total hazard" waste classification system required by the state's LLW management law, M.G.L. c.111H (Chapter 111H). That system is described in detail in Chapter 4 of VOLUME II of this plan. It must categorize all LLW generated, treated or disposed of in the Commonwealth primarily on the basis of:

- the radiological toxicity and radioactive half-life² of the radioactive material in the waste;
- the principal radionuclides present in the waste, and their concentrations, specific radioactivity, chemical and biological toxicity and form, chemical reactivity, and volume; and
- other characteristics that the Low-Level Radioactive Waste Management Board (Management Board) determines are necessary to properly manage all types of LLW. [M.G.L. c.111H, section 12(b)(1)]

A survey is conducted annually by the Management Board to collect data on all of the licensed and registered users of radioactive materials in the Commonwealth. The survey is required pursuant to section 7 of Chapter 111H, which mandates the collection of information concerning the type, volume, radioactivity, sources and characteristics of the LLW generated, treated, stored, transported or disposed of, as well as the radioactive materials users' current and projected LLW management activities. These activities include minimizing the radioactive material "sources" which result in LLW as a by-product of their use; reducing the volume of LLW which is generated; storing LLW on site to allow waste containing short half-life material to decay to very low radiation levels so that it can be disposed of as essentially non-radioactive trash; and treatment, packaging and transportation practices.

Survey results assist the Management Board in establishing policy on LLW storage, treatment and disposal. For example, information from the 1990 survey led the Board to conclude in January, 1991, that no need existed to site, construct, and operate an interim centralized storage facility³ in the Commonwealth for waste produced by "small" volume generators after 1992, when the three states which currently provide disposal will have closed their sites to LLW generators from Massachusetts and other states. The 1990 survey results revealed that all "large" volume generators had the capacity to store their waste on site until a disposal solution was found. The results also showed that no small volume generators would have "serious" space problems in conducting on-site storage.

² The "half-life" is the time in which half of the atoms of a particular radioactive substance disintegrate to another nuclear form. The unit used to measure radioactivity is the "curie," and represents the quantity of material that undergoes 3.7×10^{10} disintegrations per second.

³ The U.S. Nuclear Regulatory Commission (NRC), which licenses and regulates the use of radioactive materials in the Commonwealth, does not allow LLW storage as a substitute for disposal. "Interim" storage may be conducted for no longer than a five-year period. A detailed discussion of interim storage policies can be found in Chapter 11 of VOLUME II.

Survey data from the 1991 questionnaire continued to support the Management Board policy regarding the ability of both large and small volume LLW generators to provide on-site storage on an interim basis after access is lost to the disposal sites.⁴ Data also led the Board to make the "determinations of need" regarding siting, development, operation and closure of storage, treatment or disposal facilities within the state, as required by Chapter 111H.

Those determinations are discussed in depth in Chapter 14 of VOLUME II. In summary, the Management Board determinations of need are:

- Centralized storage facility As long as on-site storage is possible, no need exists through the latter part of the 1990's to establish a centralized storage facility in the state. However, an interim storage facility may be an appropriate solution if the Commonwealth were able to arrange for another state to accept Massachusetts-produced LLW at a future date within the operational period allowed by such an interim storage facility.
- Treatment facility Because over 20 commercial treatment facilities operate throughout the country to process LLW for later disposal, no need exists to establish an in-state LLW treatment facility at the present time or through the next decade. While a question still exists whether or not limitations may be placed on the importation of waste to out-of-state treatment operations, it is likely that treatment will continue to be available through regional and state agreements, and the Management Board is negotiating such agreements to ensure treatment facility access. Out-of-state treatment capacity should be monitored continuously to ensure its availability and quality of operational practice over time.
- Disposal facility The availability of the disposal sites in South Carolina, Nevada and Washington will soon end. In addition, new disposal facilities in various stages of development disallow access as a result of state or regional compact⁵ law, or policy. A need exists, therefore, to provide disposal for the approximately 30,000 cubic feet of LLW annually produced in the Commonwealth, plus over 450,000 cubic feet of wastes which will result from the decommissioning of the Yankee Rowe and Pilgrim nuclear power plants and possibly other large radioactive materials users in the Commonwealth. Despite the shortfall of disposal capacity, the Management Board has not made a determination yet whether or not to site a disposal facility within the Commonwealth. The Board continues to aggressively pursue access to out-of-state treatment and disposal facilities.

VOLUME III of the Low-Level Radioactive Waste Management Plan describes past and present survey methodologies, trends in information since yearly data collection began for the 1989 survey year, and summaries of the most recent survey (1991). It also describes the results of a survey of economic-based questions, which provides an illuminating picture of the financial impact of radioactive materials users on the Massachusetts economy.

Copies of the 1991 Massachusetts Low-Level Radioactive Waste Survey Report, the annual

⁴ The 1985 federal Low-Level Radioactive Waste Policy Amendments Act authorized the three states that currently provide disposal for LLW produced in Massachusetts and other states the authority to cease accepting waste from outside their regions after 1992. Those states are South Carolina, Washington and Nevada.

⁵ A "regional compact" is a legislatively-authorized contract between states, which provides assurances of long-term commitments and continuing cooperation. Compact language is ratified by each state's Legislature and then by Congress.

description of the yearly survey, are available by contacting the Management Board office at 100 Cambridge Street, Room 903, Boston, MA, 02202 (telephone [617] 727-6018).

1.2 History of Radioactive Materials Users Surveys in Massachusetts

A survey of radioactive materials users in the Commonwealth has been conducted annually by the Management Board to collect 1989 and subsequent years' data. Prior to the establishment by the Management Board of a yearly survey questionnaire, required pursuant to section 7 of Chapter 111H, two earlier surveys were conducted:

- (1) Low-Level Radioactive Waste Management Survey, prepared by EG&G Idaho, Inc. for the Department of Energy (DOE) and the Massachusetts Department of Public Health, October, 1982;
- (2) The Analysis of Low-Level Radioactive Wastes Generated in Massachusetts, prepared by Stone & Webster Engineering Corporation and the Analytic Sciences Corporation for the Massachusetts Special Legislative Commission on Low-Level Radioactive Waste, April, 1985.

The intent of the 1982 survey was to determine what data needed to be collected from LLW generators and to develop a suitable questionnaire to elicit this information from them. The 1985 survey was part of a study conducted by the Massachusetts Special Legislative Commission. The Commission, appointed by the Governor and Legislature, was charged with conducting a state-wide assessment to evaluate the LLW management situation in the Commonwealth and recommend solutions. The 1982 and 1985 surveys were one-time events that used unrelated methods to gather LLW information.

The 1982 waste management questionnaire, developed by Inter/Face Associates Inc., incorporated input from the Massachusetts Department of Public Health (DPH) Radiation Control Program and EG&G Idaho (the contractor which administers the U.S. Department of Energy's LLW management program). The form contained four sections and 22 questions, with each section pertaining to a different "class" of radioactive materials user as follows:

- (1) licensees who no longer use radioactive material;
- (2) licensees who use radioactive material but do not generate LLW;
- (3) licensees who generate LLW but can eliminate the radioactivity through the treatment of waste by storage for decay, or other management methods, and therefore do not ship waste to a licensed LLW disposal facility; and
- (4) licensees who ship LLW for disposal.

The 1982 questionnaire was sent to 390 NRC licensees in the Commonwealth, of whom 98.2% responded. The results revealed that 266,253 cubic feet of waste was shipped for disposal in 1981, with 52% produced by the commercial sector, 38% by utilities, 6% by medical generators, and 4% by the academic sector.

The 1985 survey involved personal interviews with 12 generators that produced the majority of LLW in the Commonwealth. They were: Massachusetts Institute of Technology, Harvard University, Damon Biotech, Travenol-Genentech, Boston Edison, Yankee Atomic, Nuclear Metals, Du Pont NEN Products, M/A

Com, Cambridge Medical Diagnostics, Boston University Medical Center, and the U.S. Army Materials Testing Laboratory.

The goal of each interview was to:

- (1) obtain actual data on waste volumes shipped for disposal;
- (2) obtain estimates of waste projections based on:
 - a. present and future volume reduction techniques;
 - b. present and future business plans;
 - c. present and future technologies as applied to their areas of business;
 - d. economics of generating wastes;
 - e. characteristics of waste shipped for disposal; and
- (3) develop the basis for a planning document for the management of LLW in the Commonwealth.

The results of that survey revealed that in 1984, 180,348 cubic feet of waste was shipped for disposal. The report did not provide an extensive breakdown of the survey data, but it did make volume and classification projections through the year 2020. The study estimated that 96% of all Massachusetts LLW is Class A. The volume projected to require shipment for disposal in 1991 was 122,000 cubic feet. Considering this projection and the fact that the volume actually shipped for disposal in 1991 was 42,686 cubic feet, a significant improvement has been made by the generator community in limiting the amount of LLW produced and packaged for disposal.

Annual Survey Initiated

Beginning in 1989, the Management Board has surveyed LLW generators annually. Chapter 111H requires the yearly collection of LLW data, and directs either the DPH or the Management Board to conduct this task. Information required by law to be gathered annually includes:

- detailed and accurate information concerning the type, volume, radioactivity, source and characteristics of the LLW generated, treated, stored, transported or disposed of;
- current and projected LLW management activities, including source minimization, volume minimization, on-site storage, treatment, packaging and transportation practices; and
- any other information determined to be necessary by the Board or DPH.

Since the first Management Board survey, questions have been added or eliminated each year in an effort to streamline the survey instrument, and to sort out the fundamental areas where data needed to be collected. The current survey form, used for the collection of 1991 and 1992 LLW data, is based on earlier surveys but is presented in a spreadsheet format that facilitates the electronic storage and manipulation of the data. For the collection of 1992 and subsequent years' data, the Management Board has made the form available on computer disk, for ease of completion and data compilation.

1.3 Survey Form Description

The present survey consists of 13 parts. Each part relates to a different aspect of LLW management summarized below.

Part I: General Information. This part requests the company or institution's license and product information as well as a signature certifying the accuracy of the information. In addition, questions are asked as an initial screen to identify users of radioactive materials that did not produce LLW during the survey year, and those that used radioactive materials in "sealed sources," only, which encapsulated that material to prevent the generation of waste. For those radioactive material users, who meet both criteria, completion of the rest of the survey is not required.

Part II: Waste Category Identification. This part requests the name of the city and county where waste is generated and a general description of the waste.

Part III: Waste Handled or Processed Off-Site By Others. This part requests the volume and activity of waste that is handled by companies, known as "brokers," which arrange for the collection, transportation, treatment, storage or disposal of the LLW, as well as "processors" who operate LLW treatment facilities.

Part IV: Physical and Chemical Properties. This part requests information about the physical matrix and the chemical or hazardous properties of the waste, and information regarding on-site treatment.

Part V: Disposal Data for Wastes Shipped for Off-Site Disposal This Year. This part requests a physical description of the disposal container, the NRC disposal class, disposal volume, and the disposal location.

Part VI: Data for Wastes Placed in Storage for Future Off-Site Disposal. This part requests information identical to Part V but for wastes placed in storage for future off-site disposal. Most LLW in this category is known as "mixed" waste because it is contaminated with toxic chemical "hazardous" waste. Because the present LLW disposal sites do not accept most types of mixed waste, and due to the lack of available treatment nationally to eliminate all hazardous waste components, generators of mixed waste are forced to store waste on-site. Other waste in this "storage for future off-site disposal" section of the survey may be waste the generator hopes can be recycled and reused, waste being stored for partial decay before it is shipped for disposal, or waste being held for consolidation to provide more efficient shipments.

Part VII: Other Waste Management Methods Used This Year for Radioactive Materials. This part requests volume and activity data on waste that was managed by storage for decay or other NRC licensed methods such as sewer or atmospheric disposal.⁶ In addition, data for wastes recycled or returned to the

⁶ Minute quantities of radioactive materials do not have to be disposed of in licensed LLW disposal facilities under 10 CFR Part 20 of the NRC regulations. This rule allows 0.05 microcuries or less of hydrogen-3 (H-3) or carbon-14 (C-14) per gram of medium used for liquid scintillation counting, or 0.05 grams or less of the same radionuclides per gram of animal tissue "averaged over the weight of the entire animal" to be disposed of as non-radioactive trash. Other nuclides may be released into air or water following standards set in Part 20 regulations. These tables appear in VOLUME IV of this Management Plan. In addition, NRC regulations prohibit the disposal of licensed material into sanitary sewer systems except for very small quantities which will be diluted by the volume of sewage flowing through the system. No more than a combined total of one curie per year of all radionuclides is permitted to be disposed of in this fashion, with the exception of C-14 and H-3. Up to one curie per year of C-14, and as much as five curies per year of H-3 may be released into sanitary sewers. [10 CFR 20.2003(a)4]

manufacturer are to be reported here.

Part VIII: Expected Waste Category Changes. Expected future changes in LLW volume, activity and radionuclide content are requested by this part of the form.

Part IX: Total Waste Accumulated in Storage for Off-Site Disposal. This part requests the volume, activity and predicted treatment of LLW that has accumulated in storage on site for future disposal.

Part X: Waste Category Termination, Decontamination, and Decommissioning Information. This part requests the volume, activity, description, and predicted disposal class of waste that will be produced as a result of facility decontamination or decommissioning.

Part XI: Radiological Data. This part requests the curie content of the waste, radioisotopic quantities, and radiation levels at the surface of the waste container.

Part XII: Number of Waste Shipments By Type Made This Year. This part requests data on the type and quantity of shipments made to brokers, processors, or directly to disposal sites.

Part XIII: Waste Quantity Projections. The last part of the survey form requests generators to make projections of their LLW activities for the upcoming three years.

Classification Code Sheet

An integral part of the survey form is the classification code sheet. The sheet contains specific codes to be used on the survey form to describe characteristics of particular interest. Codes are provided for the following parameters:

- (1) county in which waste is generated;
- (2) waste category description;
- (3) general and U. S. Environmental Protection Agency (EPA)/Massachusetts Department of Environmental Protection (DEP) treatment methods;
- (4) broker/processor utilized;
- (5) physical matrix;
- (6) EPA/DEP hazard code;
- (7) chelating agents;⁷
- (8) disposal site utilized;

⁷ "Chelating agents" means certain organic compounds capable of forming (multiple) coordinate bonds with metals through two or more atoms of the organic compound, typically resulting in enhanced thermodynamic stability in solution and greatly altered behavior of the metal ions. Examples include amine polycarboxylic acids (e.g., EDTA, DTPA), and polycarboxylic acids (e.g., citric acid, carboxylic acid, and gluconic acid). Chelating agents are used in decontamination processes to reduce or eliminate metals from radioactively-contaminated solutions.

- (9) NRC disposal classification;
- (10) storage site utilized;
- (11) alternate waste management methods; and
- (12) NRC/U.S. Department of Transportation (DOT) waste transportation class.

The code system precludes the need to predetermine an alpha numeric code for each type of waste. Instead, wastes are described by a combination of codes, thus allowing each individual waste stream to be classified for management purposes.

Once the survey form is completed by the generator, and returned to the Management Board, the information is entered directly from the form into a database program. The database program serves as an analytical tool which can be used to compile data by any characteristic code of interest. For example, it can be used to create summary charts and graphs which may be needed for reports or public presentations. It also allows the Management Board to quickly access information that may be requested by other public and private LLW organizations around the country, and enables the Board to annually update waste predictions in order to plan disposal needs in the future.

The Management Board's present survey form represents a new way for LLW information to be obtained in Massachusetts. The spreadsheet form, coupled with the database program, not only allows for quicker processing and compilation of LLW information, but also is a key element of the Massachusetts LLW "total hazard" classification system, described in detail in Chapter 4 of VOLUME II.

1.4 Summary of Management Board Survey Information, 1989 to 1991

Data from the annual surveys for 1989, 1990, and 1991 reveal some interesting information about LLW in Massachusetts, and have been used by the Management Board to evaluate LLW management policies and procedures.

Tables and figures in this section present three years of actual data plus three years of projections supplied by the generators in the most recent survey. Values have been rounded using standard methods and may not equal 100%. Much of the information is grouped by "category" of generator, of which there are five:

- (1) Academic (Acad) - universities, colleges and other research institutions;
- (2) Commercial (Comm) - organizations such as biotechnology, engineering, and construction companies; testing laboratories; radiopharmaceutical manufacturers and suppliers; defense contractors; and companies using radioactive materials for process and quality control and analysis;
- (3) Government (Govt) - local, state, and federal entities such as water districts, transportation departments and health departments;
- (4) Health - hospitals, clinics, and physicians; and
- (5) Utility - electric power companies that operate nuclear power plants.

Volume Shipped for Disposal

Table 1-1 and Figure 1-A show the total LLW volume which was shipped for disposal in 1989-1991, and projections of 1992-1994 volume requiring disposal in a licensed LLW disposal facility. The projections vary with the changing business plans of the radioactive materials users. Disposal facilities are located in Barnwell, South Carolina; Hanford, Washington; Beatty, Nevada; and Clive, Utah.⁸ Federal law allows the three state facilities to terminate access to LLW generators outside of their regions after Dec. 31, 1992. Washington and Nevada have decided to close their sites to the rest of the country; the Southeast Compact Commission, on behalf of the South Carolina site, is negotiating up to 18 months of additional access through June 30, 1994. Such access is not automatic, and the Management Board has undertaken aggressive actions to retain access for the LLW generators in this state. Once all disposal facilities are closed, LLW generators will be forced to store their waste on site until disposal capacity becomes available.

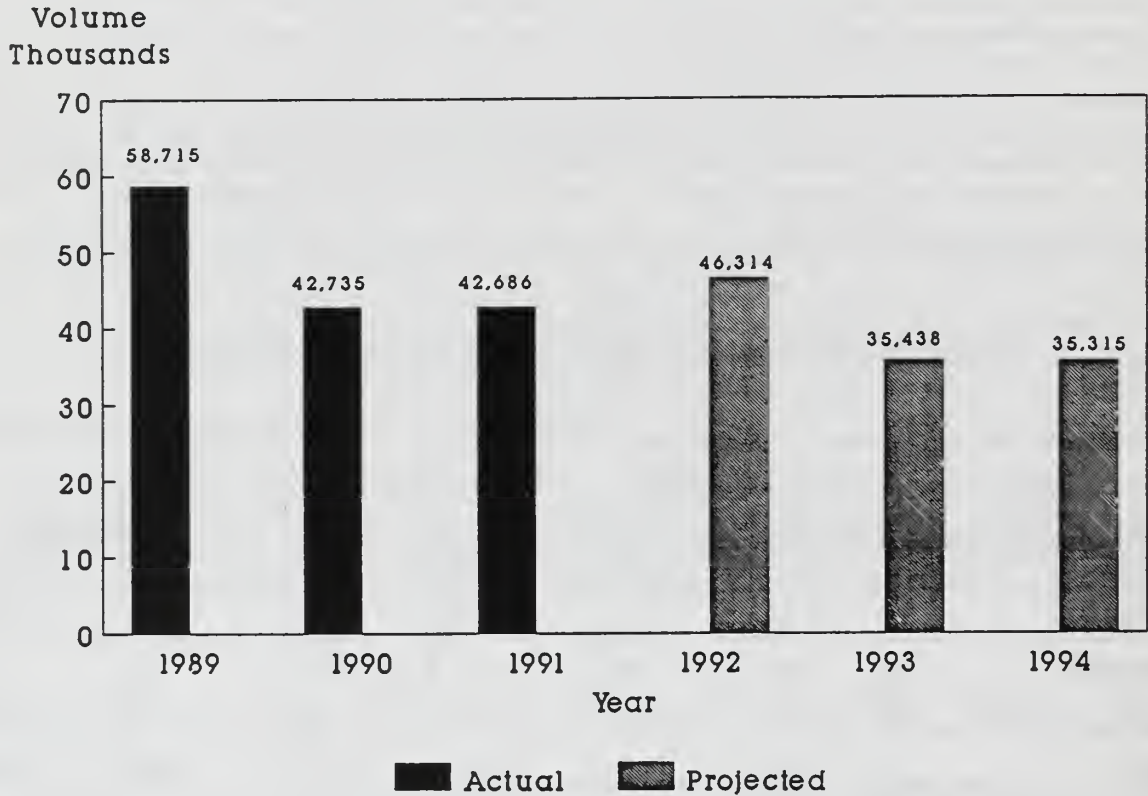
Table 1-1
Actual and Projected LLW Volume Shipped for Disposal 1989-1994
(cubic feet)

Generator Category	Actual			Projected		
	1989	1990	1991	1992	1993	1994
Academic	2,407	1,863	1,410	1,338	851	1,023
Commercial	35,950	16,681	21,646	16,520	11,973	11,667
Government	609	1,002	14	2,011	14	18
Health	2,116	3,288	1,471	4,222	1,758	1,844
Utility	17,633	19,406	18,145	21,715	18,955	18,955
Total	58,715	42,240	42,686	45,806	33,551	33,507

Source: Massachusetts Low-Level Radioactive Waste Management Board, 1992.

⁸ Most of the LLW produced nationally and in Massachusetts is disposed of in the first three state-run disposal sites. The last site, in Clive, Utah, is a privately-run commercial operation, and accepts very little waste classified as LLW. The Clive, Utah, facility operates primarily for the disposal of another radioactive waste called Naturally-Occurring Radioactive Material (NORM) waste, which is generally high volume waste containing low radioactivity, like soil.

Figure 1-A
Actual and Projected LLW Disposal Volume 1989-1994
(cubic feet)



Source: Massachusetts Low-Level Radioactive Waste Management Board, 1992.

Tables 1-2 through 1-4 break down volume data by three of the four disposal classes used by the NRC and the Commonwealth. The four classes are:

Class A waste is characterized by their low concentrations of long-lived radionuclides and concentrations of short-lived radionuclides that will decay to acceptable levels within a 100-year institutional control period, when a disposal facility is maintained after closure. These concentration limits, specified in 10 CFR 61, have been calculated on the basis of acceptable dose limits to an inadvertent intruder who might occupy the disposal site and encounter waste after this time.

Class B is the next level of wastes which could represent a potential hazard to an inadvertent intruder without additional protective measures, since they contain higher levels of short-lived radionuclides. They must meet the NRC's minimum stability requirements so that the waste forms or containers can "maintain gross physical properties and identity, over 300 years" [Part 61.7(b)(3)], thus limiting the exposure to a potential intruder.

Table 1-2
Actual and Projected Class A LLW Volume Shipped for Disposal 1989-1994
(cubic feet)

Generator Category	Actual			Projections		
	1989	1990	1991	1992	1993	1994
Academic	2,407	1,863	1,410	1,338	851	1,023
Commercial	35,852	16,471	21,449	16,385	11,883	11,532
Government	609	1,002	14	2011	14	18
Health	2,112	3,283	1,469	4,220	1,755	1,841
Utility	16,484	19,081	17,438	18,000	16,500	16,500
Total	57,464	41,700	41,780	41,954	31,003	30,914

Source: Massachusetts Low-Level Radioactive Waste Management Board, 1992.

Class C wastes are wastes that, due to their greater concentrations of long-lived or short-lived radionuclides, must meet more stringent waste form requirements to ensure stability, and must be disposed of in such a way to protect the inadvertent intruder for a longer period of time. These wastes must meet the stability requirements for form or container (300 years) and must be disposed of in a manner which protects against inadvertent intrusion for at least 500 years [Part 61.52(a)(2)].

Table 1-3
Actual and Projected Class B LLW Volume Shipped for Disposal 1989-1994

Generator Category	Actual (cubic feet)			Projections (cubic feet)		
	1989	1990	1991	1992	1993	1994
Academic	0	3	0	0	0	0
Commercial	98	210	183	135	0	135
Government	0	3	0	0	0	0
Health	4	5	1	2	3	0
Utility	1,149	325	202	2,000	2,000	2,000
Total	1,251	540	386	2,137	2,093	2,138

Source: Massachusetts Low-Level Radioactive Waste Management Board, 1992.

Table 1-4
Actual and Projected Class C LLW Volume Shipped for Disposal 1989-1994
(cubic feet)

Generator Category	Actual			Projected		
	1989	1990	1991	1992	1993	1994
Academic	0	0	0	0	0	0
Commercial	0	0	15	0	0	0
Government	0	0	0	0	0	0
Health	0	0	0	0	0	0
Utility	0	0	505	1,715	455	455
Total	0	0	520	1,715	455	455

Source: Massachusetts Low-Level Radioactive Waste Management Board, 1992.

Greater than Class C (GTCC) are wastes whose concentrations of radioactive isotopes generally make them unacceptable for the types of disposal used for Classes A, B, and C. GTCC wastes continue to be the responsibility of the federal government, not the states.

A table with GTCC waste information is not included because of the small amount of this type of waste. In 1989 only one cubic foot of GTCC waste was shipped from a generator. This waste was treated to reduce the radionuclide concentration so the waste could be disposed of as Class B waste. For the years 1992-1994, no GTCC waste is predicted to be disposed of, except by one commercial generator that estimates a few cubic feet will be produced in 1992. It is likely that this waste will also be treated to reduce its radionuclide concentration in order for it to be shipped for disposal.

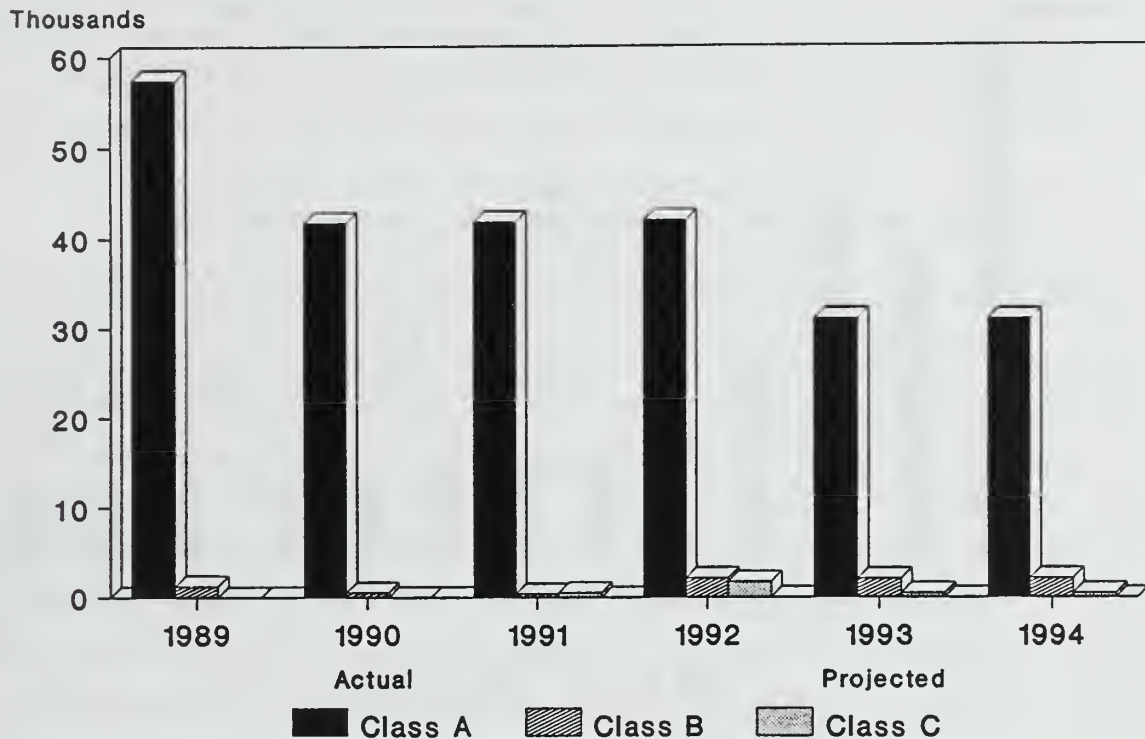
Figure 1-B illustrates graphically the composition of LLW in Massachusetts. Class A, the category containing the lowest concentrations of long-lived radionuclides, is shown to dominate the LLW stream now and in the future, representing more than 95% of the total waste stream requiring disposal.

The trends shown on the preceding tables and figures represent a continuation of the overall reduction of LLW shipped for disposal by Massachusetts generators during the last decade, as illustrated in Figure 1-C. Based on this data, and other information supplied by the generators, the Management Board has predicted that the annual Massachusetts LLW volume requiring disposal in a licensed LLW disposal facility will level off at approximately 30,000 to 35,000 cubic feet by the mid-1990's. The Board's 1992 survey requested data on all LLW activity during that calendar year, and on volume projections through the year 1995. This information will be used to confirm and update the Board's waste volume projections.

The waste projections do not include decommissioning waste from the eventual shutdown of both nuclear powered electric generating plants in the Commonwealth or the possible decommissioning of other large-scale users of radioactive materials in this state. However, they do include annual volumes produced by the utility plants, which would cease, and be replaced by short-term rises in disposal volumes for a few years, during the period when the decommissioning waste becomes available for disposal.

The Yankee Atomic Electric plant in Rowe, Massachusetts, was voluntarily shut down in October,

Figure 1-B
Actual and Projected Class A, B, C LLW Disposal Volume 1989-1994
(cubic feet)



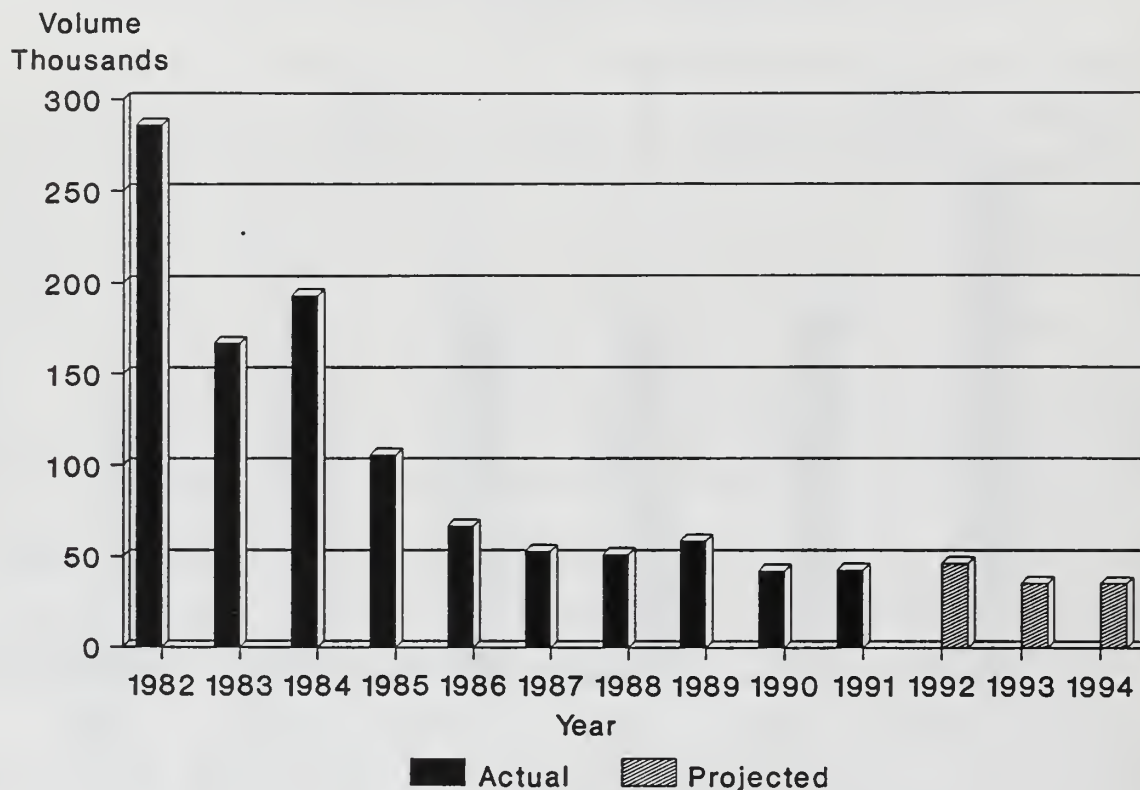
Source: Massachusetts Low-Level Radioactive Waste Management Board, 1992.

1991, and the process to begin dismantlement and decommissioning was announced in February, 1992. Once the Yankee decommissioning plan is finalized, and approved by the NRC, the removal of all LLW still at the Rowe site is expected to take several years. The total volume of LLW estimated by Yankee Atomic to be generated from their decommissioning is 94,000 cubic feet.

Similarly, Boston Edison Company has projected that the decommissioning of the Pilgrim Nuclear Power Station in Plymouth, Massachusetts, will produce approximately 288,000 cubic feet of LLW requiring disposal, when that facility is decommissioned.⁹

⁹ The Pilgrim Station license expires in the year 2012. Boston Edison could close the plant early, as did Yankee Atomic; it could close on the scheduled license expiration date of 2012; or it could seek approval of a license extension. Company officials indicate it is too soon to make any decision about the end date of Pilgrim's operation, and the period of decommissioning.

Figure 1-C
Historical and Projected LLW Volume Trends
(cubic feet)



Source: Massachusetts Low-Level Radioactive Waste Management Board, 1992.

LLW from the decommissioning of other RAM user facilities can also be expected in the future, although the quantities from any individual facility are not expected to approach the volumes estimated for the two power reactors. For planning purposes, the Board has estimated that total decommissioning waste volumes that might be expected in the years 2000-2029 to be approximately 600,000 cubic feet. Additional information about decommissioning volume estimates can be found in Chapter 14 of VOLUME II.

Projections of Radioactivity

Unlike the projection of an equalized level of future LLW volumes, the projections of radioactivity¹⁰ in the waste show a fluctuation over the same period. Table 1-5 and Figure 1-D represent three years of reported data and three years of generator projections on the amount of activity, measured in curies,

¹⁰ The "radioactivity" or "activity" of LLW is the rate at which radioactive contaminants in the waste emit radiation.

contained within the LLW.

The fluctuations in the radioactivity of the waste do not have any relationship to the total volumes of LLW requiring disposal. The total activity in 1989 was only half the activity level reported for 1990, although total waste volume dropped from 58,715 cubic feet to 42,240 cubic feet that year. In the following year, 1991, waste volume remained almost constant, however activity plunged to 32,531 curies.

The Management Board estimates that the total activity of LLW requiring disposal will continue to fluctuate in the future, as demand for products and services utilizing radioactive materials ebbs and flows with changing economic conditions and expanding medical research and biotechnology enterprises in the state. The Board intends to use its 1992 and subsequent years surveys to monitor this projection.

Table 1-5
Actual and Projected LLW Activity Shipped for Disposal 1989-1994
(curies)

Generator Category	Actual			Projected		
	1989	1990	1991	1992	1993	1994
Academic	14	12	36	106	116	6
Commercial	56,853	110,389	31,626	48,178	33,326	48,511
Government	12	2	1	5	0	0
Health	13	8	71	38	33	33
Utility	300	671	797	1,860	50,808	1,308
Total	57,192	111,082	32,531	50,187	84,283	49,858

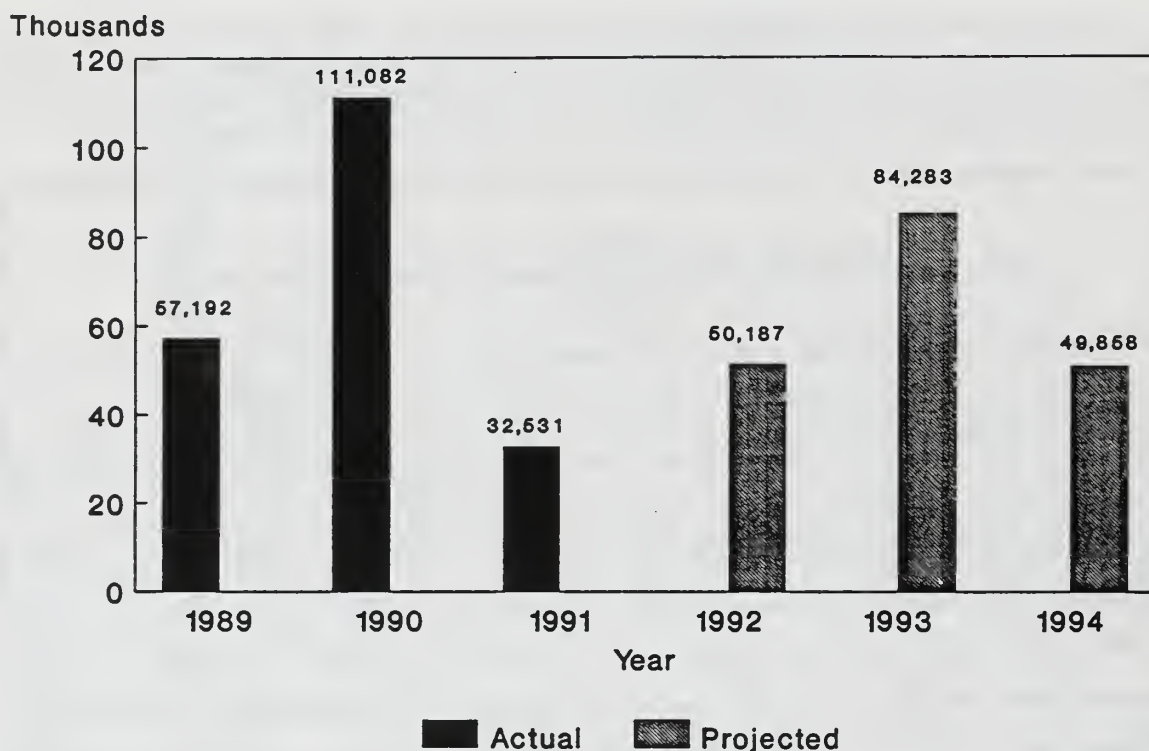
Source: Massachusetts Low-Level Radioactive Waste Management Board, 1992.

LLW Volume Managed by Storage for Decay

The survey data shows a practice which is used extensively by LLW generators in Massachusetts and elsewhere. This treatment practice is called "storage for decay," and refers to a procedure in which LLW with a relatively short half-life is held for natural radioactive decay in compliance with federal and state regulations. At the end of the storage period, the radioactivity has reduced to background levels, allowing it to be disposed of as non-radioactive trash.

Storage for decay is practical for waste that contains radionuclides with relatively short half-lives. A rule of thumb has been that after a decay time of approximately 10 half-lives, the initial activity will have decayed sufficiently to allow disposal of this material with other solid waste. This decay period, coupled with NRC license limitations on the quantities of materials and LLW that may be stored on site, limit storage for decay as a management technique to wastes that contain radionuclides with half-lives of less than 60-90 days, based on a three-year storage limit. However many of the isotopes used by commercial and medical generators have half-lives that are much less than 60-90 days, and therefore, storage for decay is a common

Figure 1-D
Actual and Projected Total LLW Disposal Activity 1989-1994
 (curies)



Source: Massachusetts Low-Level Radioactive Waste Management Board, 1992.

practice.¹¹ Table 1-6 indicates the increasing trend towards storage for decay management. The totals show that waste stored for decay is comparable in volume to waste shipped for disposal to licensed LLW facilities.

Generators who practice storage for decay must store their waste in suitable containers within a designated area, and ensure that exposure limits specified in NRC regulations are followed.

¹¹ The NRC is currently evaluating their policies on on-site storage and is expected to allow storage for up to five years. If this standard becomes effective radionuclides with half-lives up to 180 days may be able to be stored for decay.

Table 1-6
Actual and Projected Volume of LLW in Storage for Decay 1989-1994
(cubic feet)

Generator Category	Actual			Projected		
	1989	1990	1991	1992	1993	1994
Academic	10,063	5,309	7,119	7,125	8,508	9,843
Commercial	22,469	5,753	18,010	17,799	18,720	18,978
Government	21	14,490	37	28	21	21
Health	9,509	1027	13,053	14,143	14,106	14,720
Utility	0	0	0	0	0	0
Total	42,053	26,579	38,219	39,095	41,355	43,562

Source: Massachusetts Low-Level Radioactive Waste Management Board, 1992.

Mixed LLW Volume Stored On-Site for Future Off-Site Disposal

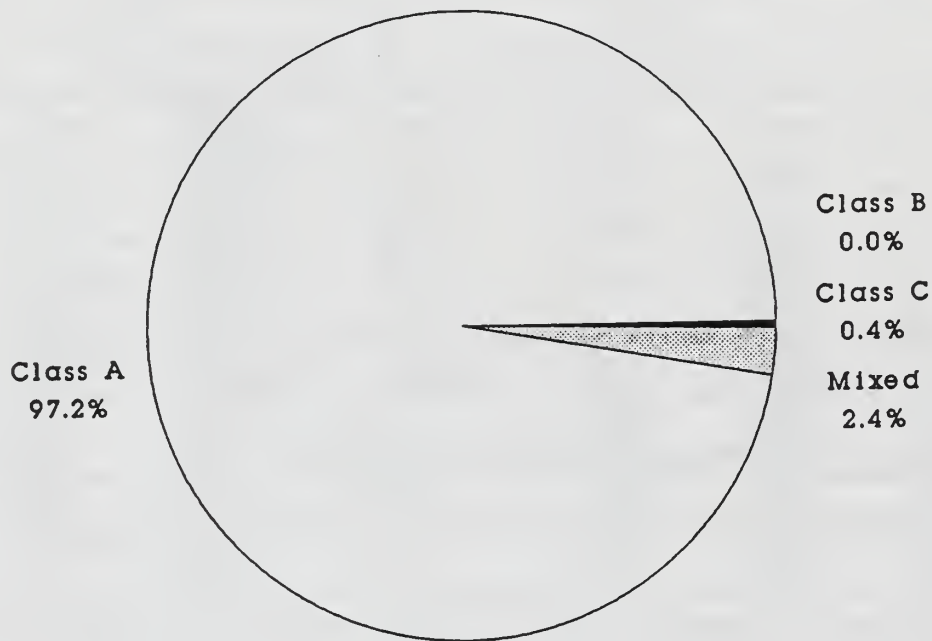
As noted, one of the sections of the annual survey form requests information regarding all LLW stored on-site for future off-site disposal. This information is collected to aid the Management Board in evaluating the sizes of any centralized storage or disposal facilities as part of its deliberations on the need to site either or both such facilities in the Commonwealth, and in connection with the Board's discussions with other states about possible outside-Massachusetts disposal solutions. The Board reviews data on waste shipped for disposal, data on waste in storage for future disposal, and information about LLW which may be removed from old burial sites¹² during present or future clean-up activities.

Figure 1-E illustrates the types of LLW being stored on-site for future disposal, based on the 1991 survey. As shown, the majority of this waste is Class A.

Table 1-7 shows the volume of mixed waste placed in storage during 1989-1991. Because federal law assigning LLW management and disposal responsibility to each of the 50 states includes mixed waste, Massachusetts must find disposal solutions for this material. The Commonwealth has joined other states in requesting that the DOE provide for mixed waste disposal, since the vast majority of mixed waste produced in the United States comes from DOE. Several states that have identified sites for new LLW disposal facilities, including California and Nebraska, are not building mixed waste disposal units in the hope that the DOE solution will occur.

¹² Prior to the early 1960's, when the first LLW site opened in Beatty, Nevada, for use by commercial (non-government) generators of LLW, the Atomic Energy Commission (the predecessor of the NRC) allowed disposal of certain radioactive waste by burial at the site where the waste was produced. Some of the sites have been identified in Massachusetts, and are described in Chapter 14 of VOLUME II of this Management Plan. Depending upon if, and when, any of the LLW in these sites is removed, it may become the state's responsibility to arrange for its disposal.

Figure 1-E
Types of LLW in Storage for Future Off-Site Disposal
(Percentage of Volume)



Source: Massachusetts Low-Level Radioactive Waste Management Board. 1991 Massachusetts Low-Level Radioactive Waste Survey Report. Boston, MA, November, 1992.

1.5 Characteristics of Massachusetts LLW Generators

The Massachusetts LLW management law, Chapter 111H, requires this Management Plan to include an inventory of all Massachusetts generators, including information on their location, products, services, clinical procedures, and teaching and research activities; assessment of the economic impact to the Commonwealth; the volume, characteristics, and curies of their current and projected LLW streams; and management practices involving source and waste volume minimization, on-site storage, treatment, packaging and transportation. The 1991 LLW survey provides the most up-to-date information to meet the generator inventory requirement of the law. The 1991 survey was mailed to all licensed and/or registered users of radioactive materials in the Commonwealth, of which there were 461 at the time of the survey's

Table 1-7
Mixed LLW Placed in Storage for Future Off-Site Disposal 1989-1991
(cubic feet)

Generator Category	Year		
	1989	1990	1991
Academic	1,185	23	31
Commercial	11,488	519	125
Government	0	0	0
Health	1,475	28	17
Utility	158	0	0
Total	14,306	576	173

Source: Massachusetts Low-Level Radioactive Waste Management Board, 1992.

distribution.¹³ The response to the survey was 95%.

Of these 461 surveyed, 232 indicated that their use of radioactive materials resulted in the production of LLW; the remainder used sealed sources¹⁴ or did not possess radioactive materials (even though licensed to use such material), and therefore, did not produce any LLW.

Of the 232 organizations which produced LLW, 103 indicated that they shipped all or part of their waste for disposal to one of the four licensed disposal facilities. The remainder were able to manage their waste in a manner other than licensed land disposal, such as storage for decay. Some generators managed their waste by both shipping it to a licensed disposal facility and storage for decay or another approved method, such as sewer disposal. During 1991, Massachusetts generators produced 152,292 cubic feet of LLW. Of this amount:

- 42,686 cubic feet (28.0%) required disposal in a licensed disposal facility;
- 8,316 cubic feet (5.5%) was placed in storage for future off-site disposal;
- 49,727 cubic feet (32.6%) was eliminated by treatment;
- 38,219 cubic feet (25.1%) was managed by on-site storage for decay; and
- the remainder, 13,344 cubic feet (8.8%) was managed by other on-site management methods,

¹³ The total number of radioactive material licensees in Massachusetts varies from time to time due to the expiration or termination of some licenses and the issuance of new ones.

¹⁴ A sealed source is radioactive material encased in a shell of non-radioactive material which prevents the leakage or escape of the radioactive material, and therefore does not routinely produce waste.

such as incineration, recycling, and sewer disposal.¹⁵

Table 1-8 summarizes the principal methods used by LLW generators in Massachusetts to manage the waste they produced, and indicates that disposal in a licensed LLW disposal facility accounts for only one-quarter of the total waste produced. Approximately 25% of the waste is eliminated from the "LLW" category through the treatment method of storage for decay; 32% of the waste volume is eliminated by other

Table 1-8
Summary of 1991 LLW Production and Disposition
(cubic feet)

Production\Disposition	Generator Category					Total	% of Total
	Academic	Commercial	Government	Health	Utility		
Produced	18,845	66,250	726	19,745	46,726	152,291	N/A
Volume Eliminated by Treatment	2,003	17,162	14	2,011	28,537	49,727	32.6
Shipped for Disposal	1,410	21,646	14	1,471	18,145	42,686	28.0
Storage for Future Off-Site Disposal	472	6,927	660	213	44	8,316	5.5
Storage for Decay	7,119	18,010	37	13,053	0	38,219	25.1
Other Management Methods	7,841	2,505	1	2,997	0	13,344	8.8

"Other management methods" refers to those methods employed by the generator on-site, such as incineration, recycling, sewer disposal, etc.

Source: Massachusetts Low-Level Radioactive Waste Management Board. 1991 Massachusetts Low-Level Radioactive Waste Survey Report. Boston, MA, November, 1992.

treatment techniques, and less than 10% is managed through NRC-approved alternative disposal methods, such as sewer disposal. As the Management Board considers these data, they will continue to evaluate changes in the use of these management options after the three licensed disposal sites stop accepting Massachusetts waste.

Each of these management activities is further characterized by generator category in Tables 1-9 through 1-13. Table 1-9 separates the total volume of LLW produced prior to treatment and disposal by the various disposal classifications developed in the Management Board's "total hazard" waste classification system. This system, which is described in detail in Chapter 7 of VOLUME II, enables the Board to evaluate the radiological, chemical and biological toxicity of the waste generated, in connection with storage, treatment and disposal strategies.

¹⁵ More information regarding alternatives to land disposal facilities can be found in Chapter 10, section 10.7, of VOLUME II.

Table 1-9
1991 LLW Volume Produced Prior to Processing-By Disposal Class and Generator Category
(cubic feet)

Waste Class	Generator Category					Total	% of Total
	Academic	Commercial	Government	Health	Utility		
A Unstable	2,482	33,272	6	2,043	40,680	78,482	51.5
A Stable	80	801	8	882	5,295	7,066	0.0
B	0	183	0	1	202	386	0.0
B	0	53	0	0	505	557	0.0
GTCC	0	0	0	0	0	0	0.0
AU-H	99	234	0	165	0	498	0.3
AS-H	0	13	0	17	0	0	0.0
Other	16,184	31,695	712	16,637	44	65,272	42.9
Total	18,845	66,250	726	19,745	46,726	152,292	100
% of Total	12.4	43.5	0.5	13.0	30.7	100	

The waste class "other" includes: waste managed on-site by storage for decay and other management methods, waste placed in on-site storage for future disposal, and waste that did not require land disposal after treatment by a broker.

Source: Massachusetts Low-Level Radioactive Waste Management Board. 1991 Massachusetts Low-Level Radioactive Waste Survey Report. Boston, MA, November, 1992.

In addition to the NRC classes already identified, other waste categories referenced in these tables are:

A Unstable – Class A waste which has not been stabilized prior to packaging for disposal;

Class A Stable – Class A which has been stabilized prior to packaging for disposal;

AU-H – Class A unstable LLW with treated hazardous waste components;

AS-H – Stabilized Class A LLW with treated hazardous waste components;

B-H – Class B LLW with treated hazardous waste components;

C-H – Class C LLW with treated hazardous waste components;

GTCC-H – GTCC LLW with treated hazardous waste components, not suitable for near-surface disposal.

Table 1-10 reveals the percent of each generator category which shipped waste volume and activity for disposal in 1991. Table 1-11 breaks down the "other management methods" by various categories,

Table 1-10
1991 LLW Volume and Activity Shipped For Disposal-By Disposal Class and Generator
Category
(cubic feet or curies)

Generator Category	Disposal Class					Total Activity	
	Class A	Class B	Class C	Total	% of Total	Curies	% of Total
Academic	1,410	0	0	1,410	3.3	36	0.1
Commercial	21,449	183	15	21,646	50.7	31,626	97.2
Health	1,469	1	0	1,471	3.4	71	0.2
Government	14	0	0	14	3.3	1	0.1
Utility	17,438	202	505	18,145	42.5	796	2.4
Total	41,780	386	520	42,686	100	32,530	100
% of Total	97.9	0.9	1.2	100			

Source: Massachusetts Low-Level Radioactive Waste Management Board. 1991 Massachusetts Low-Level Radioactive Waste Survey Report. Boston, MA, November, 1992.

Table 1-11
1991 LLW Volume Managed by Other Management Methods

Management Method	Generator Category					Total
	Academic	Commercial	Government	Health	Utility	
Storage for Decay	7,119	18,010	37	13,053	0	38,219
Incineration ¹	2,285	297	0	1,747	0	4,329
Return to Manufacturer	0	150	0	920	0	1,070
Recycle/Recover	0	23	0	0	0	23
Sewer Disposal	5,556	2,036	0	330	0	7,992
Total	14,959	20,515	37	16,050	0	51,563

¹ After incineration the radioactive ash remaining must be disposed of in a licensed LLW facility.

Source: Massachusetts Low-Level Radioactive Waste Management Board. 1991 Massachusetts Low-Level Radioactive Waste Survey Report. Boston, MA, November, 1992.

Including the quantity of waste managed by the "storage for decay" method. Table 1-12 describes the classification and quantity of the LLW placed in storage for future disposal.

Complete 1991 LLW characterization data are reported in the 1991 Massachusetts Low-Level Radioactive Waste Survey Report published by the Management Board in November, 1992.

Table 1-12
1991 LLW Placed in Storage for Future Off-Site Disposal
(cubic feet)

Disposal Classification	Generator Category					Total	% of Total
	Academic	Commercial	Government	Health	Utility		
Unclassified	341	836	0	27	0	1,204	14.5
A Unstable	100	646	0	165	15	926	11.1
A Stable	0	5,320	660	4	0	5,984	72.0
B	0	0	0	0	0	0	0.0
B	0	0	0	0	29	39	0.3
Greater than Class C	0	0	0	0	0	0	0.0
A Unstable Hazardous	31	112	0	0	0	143	1.7
A Stable Hazardous	0	13	0	17	0	30	0.0
B Hazardous	0	0	0	0	0	0	0.0
C Hazardous	0	0	0	0	0	0	0.0
Greater than Class C Hazardous	0	0	0	4	0	0	0.0
Total	472	6,927	660	213	44	8,316	100
% of Total	5.7	83.3	7.9	2.6	0.5	100	

Source: Massachusetts Low-Level Radioactive Waste Management Board. 1991 Massachusetts Low-Level Radioactive Waste Survey Report. Boston, MA, November, 1992.

1.6 Economic Impacts

Another requirement of the state law which mandates the preparation, issuance for public review and comment, and the implementation of this Management Plan, is the provision that the plan include an evaluation of the economic benefit to the Commonwealth of all the various activities involving the use of radioactive materials. [Chapter 111H, sec. 12(b))3]]

In order to collect this information, in 1991, radioactive materials users were asked questions relating to:

- the revenue which each company or institution using radioactive materials would have lost if it

had been unable to use these materials in 1991;

- the number of employees directly involved in the use of radioactive materials; and
- those employees that are indirectly involved in radioactive materials use.

Survey responses are summarized in Table 1-13. They indicate that 16,715 employees are "directly" involved in the use of radioactive materials and the possible generation of LLW as a by-product of that use. An additional 19,415 people work for companies or institutions that use these materials. The revenues which would have been lost if radioactive materials could not be utilized are highest among the commercial category of users, exceeding \$1.7 billion dollars. Together, all users responding to the survey reported revenues of approximately \$2.97 billion dollars through the use of radioactive materials.¹⁶ This amount equals approximately 2.0% of the Gross State Product for 1989, the last year such information was available.

Table 1-13
Employment and Revenues Reported by Radioactive Materials Users-By Generator Category

Generator Category	Direct Employees	Indirect Employees	Revenues
Academic	6,356	4,034	\$539,073,298
Commercial	4,304	5,976	\$1,749,195,959
Government	7	20	\$440,000
Health	6,356	5,553	\$349,279,248
Utility	4,364	3,832	\$330,000,000
Total	16,715	19,415	\$2,967,988,505

Source: Massachusetts Low-Level Radioactive Waste Management Board. 1991 Massachusetts Low-Level Radioactive Waste Survey Report. Boston, MA, November, 1992.

Economic benefits to the Commonwealth fall into a number of areas other than employment and revenues directly attributable to radioactive materials. Not all groupings of "economic benefits" were requested in the survey. For example, data was not solicited on the portion of the total economic benefit resulting from tax revenues paid to state and local governments to help compensate for governmental services. In addition, information was not requested regarding the reinvestment of funds in these companies and institutions to encourage growth and expansion, or the profits shared by shareholders and employees to expand the level of dollars available to purchase other goods and services, or to provide further financial investment opportunities.

Other benefits to society, which are hard to quantify in monetary terms, nonetheless need to be considered in this analysis. These include: the significant medical gains achieved from the use of these materials for diagnostic and therapeutic activities, such as radioimmunoassay tests and the treatment of

¹⁶ The economic information was collected through a supplement to the 1991 survey, and only 64% of the total group receiving the survey instrument responded to this section. Were the response higher, it is assumed that the data would show larger revenues and greater numbers of involved employees.

mental retardation in newborns; the advances in medical research to find cures for cancer, multiple sclerosis and A.I.D.S.; many consumer goods in demand today, including smoke alarms, canned soft drinks, and sterilized plastics; the assurance of the quality of welds and the detection of flaws; and the ability to date and verify prehistoric and antique objects such as fossils at science museums and paintings at the Museum of Fine Arts.

1.7 LLW Transportation Data

Survey Information regarding the transportation activities of LLW generators is provided in the following three tables. Shipments shown in Table 1-14 are segregated by the three basic types of packaging required by U.S. Department of Transportation (DOT) and NRC regulations. These are "Type A," "Type B" and "strong tight containers." This third category is commonly called "LSA" packaging because it is used to transport waste in which the radioactivity in the package is uniformly distributed, and the waste has a low average concentration (i.e., "Low Specific Activity"—LSA) per gram of material. Type A and Type B packages bear no correlation to the NRC "Class A" and "Class B" waste disposal classifications.

<p align="center">Table 1-14 1991 LLW Shipments-By Type of Shipment and Generator Category</p>						
Type of Shipment	Generator Category					Total
	Academic	Commercial	Government	Health	Utility	
LSA	4	104	0	89	59	256
Type A	59	194	1	107	5	366
Type B	0	15	0	0	0	15
Total	64	312	1	196	64	637
<p>Source: Massachusetts Low-Level Radioactive Waste Management Board. <u>1991 Massachusetts Low-Level Radioactive Waste Survey Report</u>. Boston, MA, November, 1992.</p>						

Most LLW shipped in Massachusetts is packaged in Type A containers. These include fiberboard and wooden boxes, and steel drums. Waste may be packaged in fiberboard boxes for shipment to processing plants for treatment, but cannot be sent to a LLW disposal site in this form, as the NRC prohibits disposal of waste in cardboard or fiberboard packages. Most waste shipped for disposal from Massachusetts is packaged in 30- or 55-gallon steel drums.

A small number of the shipments in 1991, shown in Table 1-14, involved the use of Type B packages. These packages are steel drums with insulation built into the drum to handle the transport of LLW containing higher levels of radioactivity than that transported in Type A packages. Type B packages must meet all of the requirements of Type A containers, and must also withstand DOT and NRC accident damage test conditions.¹⁷

¹⁷ These test conditions, dictated by DOT and NRC regulations, include requirements that the package be tested in a 30-foot drop, be burned for 30 minutes at a temperature of 1,475 degrees Fahrenheit, and be immersed in water for several hours.

Additional information about packaging and shipping requirements can be found in Chapter 9 of VOLUME II of this Management Plan.

As has been noted, LLW is shipped both to treatment plants, known as "processors," and to disposal sites. Some waste is shipped directly to disposal sites, often having been treated on site by the generator, prior to shipment. Some waste is transported to a treatment facility first, and then shipped to a disposal site. Some waste is picked up by "brokers" who arrange for the collection, transportation, treatment, storage or disposal of LLW, but may not actually conduct any of those activities except for transportation and storage.

Table 1-15 breaks down the shipments by the destinations of waste shipped via brokers and to processors (Broker/Processor) and waste shipped directly to the four disposal sites referenced earlier in this volume. With the exception of one generator that reported shipping waste for disposal to the Envirocare facility in Clive, Utah,¹⁸ all other generators shipped waste to Barnwell, South Carolina; Beatty, Nevada; and Hanford, Washington.

<p>Table 1-15 1991 LLW Shipment Destination-By Generator Category</p>			
Generator Category	Destination		Total Shipments
	Broker/Processor	Directly to Disposal Site	
Academic	63	1	64
Commercial	270	42	312
Government	1	0	1
Health	193	3	196
Utility	21	43	64
Total	548	89	637
<p>Source: Massachusetts Low-Level Radioactive Waste Management Board. <u>1991 Massachusetts Low-Level Radioactive Waste Survey Report</u>. Boston, MA, November, 1992.</p>			

Many of the state's larger LLW generators by volume and activity (see Table 1-17) ship directly to the disposal sites, and use compaction and storage for decay to treat their waste prior to shipment. Most of the state's small volume (and activity) generators utilize the services of brokers to arrange for transportation, treatment, and disposal. The principal processing facilities used by Massachusetts generators are ADCO Services in Illinois, and RADIAC Research Corporation and NDL, both located in New York State. A few generators, chief among them the two nuclear power plants in the Commonwealth, use the only commercial processing facility located in Massachusetts.¹⁹

¹⁸ Nuclear Metals, inc. of Concord shipped some waste to the Utah disposal site in 1991.

¹⁹ Interstate Nuclear Services in Springfield launders radioactively-contaminated clothing worn by workers in nuclear power plants and other companies where radioactive materials are used. Once the contaminants are removed, the clothing can be reused in these facilities.

Table 1-16 summarizes shipping information reported by brokers and processors that serviced Massachusetts LLW generators during 1991. A "trip" is the length of time or distance that a vehicle spent or traveled while in Massachusetts. The "total distance traveled" is the distance in Massachusetts, only; it does not include the miles traveled outside of the state. A "pickup" is a stop made by a vehicle during a trip, for the purpose of loading LLW packages. In most instances, a single vehicle will enter Massachusetts from an out-of-state processor or brokerage firm, and pick up LLW (identified as "shipments" in Tables 1-14 and 1-15) from several different generators before leaving the state. Many of these trips occur on a monthly basis.

Table 1-16
1991 LLW Broker Trip Data

Total Trips	Total Travel Time (hours)	Total Distance Traveled (miles)	Total Number of Pickups	Total Volume Picked Up (cubic feet)	Total Activity Picked Up (curies)
59	380	15,190	379	15,225	70.736

Source: Massachusetts Low-Level Radioactive Waste Management Board. 1991 Massachusetts Low-Level Radioactive Waste Survey Report. Boston, MA, November, 1992.

1.8 Generator Inventory

In addition to the LLW generator characteristic data presented in Sections 1.5 and 1.6 of this volume, all 1991 LLW survey recipients are listed in Table 1-17 along with information on their location; individual volumes generated (or not generated as the case may be); activity; classes of waste produced; principal packages used and number of shipments made in 1991. In addition, columns describe the types of activities of each generator: products, services, clinical procedures, and teaching or research activities. When available, data on specific activities is included.

1.9 Chapter References

Massachusetts Low-Level Radioactive Waste Management Board. 1991 Massachusetts Low-Level Radioactive Waste Survey Report. Boston, MA: November, 1992.

Massachusetts Low-Level Radioactive Waste Management Board. 1990 Massachusetts Low-Level Radioactive Waste Survey Report. Boston, MA: November, 1991.

U.S. Nuclear Regulatory Commission. Title 10, Code of Federal Regulations, Part 20. Washington, DC: U.S. Government Printing Office, 1992.

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants

City	Organization	Description of Waste Shipped for Disposal					Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)					
Barnstable County											
Falmouth	Falmouth Hospital	0	0	0	0	0	S: Nuclear medicine Imaging	Storage for decay	0		
Falmouth	Marine Research, Inc.	0	0	0	0	0	O: License termination in progress				
Hyannis	Cape Cod Hospital	0	0	0	0	0	S: Nuclear medicine Imaging	Storage for decay	0		
Hyannis	Cardiac Imaging Inc.	0	0	0	0	0	S: Nuclear medicine Imaging	Storage for decay	0		
Mashpee	AGM Marine Contractors, Inc.	0	0	0	0	0	SS: Analysis of soil samples				
Woods Hole	Marine Biological Laboratory	52	0	0	52	0.09	R: Basic biomedical research	Storage for decay	0	55 Gallon Steel Drum	1
Woods Hole	U.S. Department of the Interior, U.S. Geological Survey	0	0	0	0	0	SS: Analysis of soil samples				
Woods Hole	Woods Hole Oceanographic Institute	40.1	0	0	40.1	0.1165	R: Biological & chemical research and education	Storage for decay	32	30 Gallon Steel Drum	2
Berkshire County											
Adams	Pfizer Inc./MSP Division	0	0	0	0	0	SS: Measurement of slurry density				
Dalton	Crane & Co., Inc.	0	0	0	0	0	SS: Measurement of paper thickness				
Great Barrington	Fairview Hospital	0	0	0	0	0	S: Nuclear medicine	Storage for decay			

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal				Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)				
Lee	Capfilm, Inc.	0	0	0	0	0				
Lenox	Lenox Institute of Water Technology, Inc.	0	0	0	0	0				
North Adams	North Adams Regional Hospital	0	0	0	0	0		0		
North Adams	Sprague Electric Company	8.02	0	0	8.02	0.00191		0	30 Gallon Steel Drum	2
Pittsfield	A.H. Rice Corporation	0	0	0	0	0				
Pittsfield	Beloit Corp. Research Center	0	0	0	0	0				
Pittsfield	Berkshire Medical Center	0	0	0	0	0	Storage for decay	0		
Pittsfield	General Electric Aerospace	7.5	0	0	7.5	0.000398		0	55 Gallon Steel Drum	1
Pittsfield	Hillcrest Hospital	0	0	0	0	0				
Pittsfield	J.H. Maxymilliam, Inc.	0	0	0	0	0				
Pittsfield	Scallise-Knysh Associates Inc.	0	0	0	0	0				
Williamstown	Williams College	0	0	0	0	0		4		

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal					Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)					
Bristol County											
Attleboro	Sturdy Memorial Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	Storage for decay, return to supplier	0		
Fall River	Charlton Memorial Hospital	0	0	0	0	0	C: Nuclear medicine	Storage for decay	0		
Fall River	Roentgen Associates of Fall River	0	0	0	0	0	O: License terminated				
Fall River	St. Anne's Hospital	0	0	0	0	0	S: Nuclear Medicine				
Mansfield	Clinical Science Lab	0	0	0	0	0	S: In-vitro diagnostic testing	Storage for Decay	0		
New Bedford	Pym/Dritz Corporation	0	0	0	0	0	SS: Storage of Iodine bars containing radium				
New Bedford	Saint Luke's Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	Storage for decay, return to supplier	0		
North Attleboro	Mallinckrodt Medical Inc.	20.05	0	0	20.05	.0000006	P: Manufacture and distribution of radiopharmaceutic products	Compaction, Incineration, absorption	0	30 Gallon Steel Drum	15
North Dartmouth	The Office of Drs. Horan and Jaslow	0	0	0	0	0	O: License terminated				
North Dartmouth	University of Massachusetts, Dartmouth	0	0	0	0	0	R/S: Research and teaching	Storage for decay	0		

**Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)**

City	Organization	Description of Waste Shipped for Disposal					Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)					
Norton	Wheaton College	0	0	0	0	0	R/S: Research and teaching	Storage for decay, sorting/segregation	4		
Raynham	Defeo, Walt & Assoc., Inc.	0	0	0	0	0	SS: Nuclear density meter to determine density of construction materials				
Somerset	New England Power Co.	0	0	0	0	0	SS: Used for coal and ash silo level detection and chute pluggage detection				
South Attleboro	State Line Scrap Co., Inc.	0	0	0	0	0	SS: X-ray fluorescent analyzer for metallurgical application				
Taunton	Morton Hospital and Medical Center	0	0	0	0	0	S: Diagnostic Imaging services				
Taunton	Tibbetts Engineering Corp.	0	0	0	0	0	O: License terminated				
Dukes County											
Oak Bluffs	Martha's Vineyard Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	Storage for decay, return to supplier	0		
Vineyard Haven	Kent A. Healy, P.E.	0	0	0	0	0	O: License terminated				
Essex County											
Amesbury	Amesbury Hospital	0	0	0	0	0	S: Diagnostic Imaging	Storage for decay	0		

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal					Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)					
Andover	Carroll Engineers, Inc.	0	0	0	0	0	SS: Industrial radiography				
Andover	Digital Equipment Corporation	4.01	0	0	4.01	0.25009	O: License terminated		0	7A Drum	1
Andover	Elsal Research Institute	15	0	0	15	0.015	R: R & D using Biological Assays	Incineration, storage for decay	0	55 Gallon Steel Drum	4
Andover	Raytheon Company	0	0	0	0	0	SS: Sealed sources for out-of-state use				
Beverly	Applied Infrared Technologies, Inc.	0	0	0	0	0	SS: Roof moisture testing				
Beverly	Autogen Instrumentation, Inc. No response to survey										
Beverly	Beverly Hospital No response to survey										
Beverly	New England Biolabs	0	0	0	0	0	R: Biotechnology research and development	Storage for decay	0		
Beverly	Salem and Beverly Water Supply Board	0	0	0	0	0	SS: Potable water analysis				
Beverly	Stocker & Yale, Inc.	0	0	0	0	0	SS: Used in manufacturing processes				
Beverly	Varian Associates	61.3	0	0	61.3	76.00227	P: Manufacture and sale of electron tubes		37.5	55 Gallon Drum	3

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal				Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)				
Danvers	Abioned	0	0	0	0	0	SS: Used in x-ray fluorescent research			
Danvers	Amicon Division, W.R. Grace & Co.	0	0	0	0	0	P: Measurement of properties during manufacturing processes.	Storage for decay		
Danvers	Diagnostic Management Services	0	0	0	0	0	C: Nuclear medicine studies	Storage for decay	0	
Danvers	GTE Products Corp.	0	0	0	0	0	O: License terminated			
Danvers	Hunt Center For Emergency and Ambulatory Care	0	0	0	0	0	C: Diagnostic nuclear medicine and clinical chemistry	Storage for decay	0.5	
Gloucester	Addison Gilbert Hospital	0	0	0	0	0	C: Clinical Nuclear Medicine	Store for decay	0	
Gloucester	U.S. Commerce, Marine Fisheries	0	0	0	0	0	SS: Chemical analysis instrument			
Hathorne	Charles T. Morgan Co., Inc.	0	0	0	0	0	SS: Occasional demonstrations of portable analysis units			
Haverhill	Hale Hospital	0	0	0	0	0	C: Diagnostic and therapeutic nuclear medicine	Storage for decay	1	52
Haverhill	IMI, Inc.	0	0	0	0	0	SS: X-ray of multilayer PC boards			
Ipswich	Bio-Nuclear Measurements, Inc.	0	0	0	0	0	O: License terminated			

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal				Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)				
Lawrence	Lawrence General Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine Storage for decay	0		
Lawrence	MA DEP	0	0	0	0	0	SS: Calibration sources			
Lawrence	Silverman Brothers, Inc.	0	0	0	0	0	SS: Kevelex analyzer			
Lynn	AtlantiCare Medical Center	0	0	0	0	0	C: Diagnostic nuclear medicine			
Lynn	General Electric Aircraft Engines No response to survey									
Lynn	Mt. Pleasant Hospital No response to survey						O: License terminated; hospital closed			
Methuen	Holy Family Hospital & Medical Center	0	0	0	0	0	C: Diagnostic nuclear medicine Storage for decay	0		
Middleton	F.X. Masse Assoc., Inc.	0	0	0	0	0	SS: Instrument calibration			
Newburyport	Anna Jaques Hospital	0	0	0	0	0	S: Diagnostic Imaging			
North Andover	AT&T Network Systems	0	0	0	0	0	P: Telecommunications	0		
North Andover	Borden Packaging and Industrial Products	0	0	0	0	0	SS: Thickness and density measuring devices			
North Andover	Brooks School	0	0	0	0	0	R: Uptake experiments			

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
 (continued)

City	Organization	Description of Waste Shipped for Disposal					Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)					
North Andover	Mediq Imaging Services, Inc.	0	0	0	0	0	S: Diagnostic Imaging				
North Andover	RTS Technology	0	0	0	0	0	P: Manufacture of sealed sources		22.5		
Peabody	J.B. Thomas Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	Storage for decay	0		
Salem	EG&G Inc.	21.3	0	0	21.3	0.890103	P: Development & manufacture of electron tubes	Compaction	0	55, 30 & 8 Gallon Steel Drum	5
Salem	MA Department of Fisheries, Wildlife & Environmental Law Enforcement	0	0	0	0	0	SS: Gas chromatography				
Salem	New England Chromachem	0	0	0	0	0	SS: Gas chromatography				
Salem	New England Power Co.	0	0	0	0	0	SS: Used to monitor coal flyash levels and monitor for plug chutes				
Salem	Salem Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	Storage for decay, return to supplier	0		
West Newbury	Woman's Health Care, P.C.	0	0	0	0	0	SS: Bone density measurements				
Franklin County											
Franklin	Digital Equipment Corp.	0	0	0	0	0	SS: Go/No-Go testing of ECL Sram memory devices				

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal				Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)				
Franklin	Thermo Environmental Instruments	0	0	0	0	0	SS: Instruments			
Greenfield	Dr. William Hester	0	0	0	0	0	O: License termination in progress			
Greenfield	Franklin Medical Center	2	0	0	2	0.000402	C: Nuclear medicine diagnostics and laboratory testing	2	Storage for decay	1
Rowe	Yankee Atomic Electric Co.	5557	0	240	5797	89.722	P: Electricity and laboratory services	255	Poly H/C, Metal Box in Overpack, DOT Spec 17H, 30 Gal, 55 Gal Metal Box	16
South Deerfield	John E. Cain Co.	0	0	0	0	0	O: License terminated			
Hampden County										
Chicopee	College Of Our Lady Of The Elms	0	0	0	0	0	R/S: Teaching & research	0		
Holyoke	Holyoke Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine and clinical chemistry	0	Storage for decay	
Holyoke	Providence Hospital No response to survey									
Ludlow	F&J Construction Co.	0	0	0	0	0	SS: Moisture density gauge			
Ludlow	Jack Goncalves & Sons, Inc.	0	0	0	0	0	SS: Density gauge			

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal				Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)				
Ludlow	Ludlow Hospital	0	0	0	0	0	Storage for decay, return to supplier	0		
Palmer	Tambrands, Inc.	0	0	0	0	0	SS: Mass thickness gauge			
Palmer	Wing Memorial Hospital	0	0	0	0	0	C: Nuclear medicine imaging	0		
Springfield	Allied Testing Labs	0	0	0	0	0	SS: Analysis of moisture/density of soil and asphalt			
Springfield	Baystate Medical Center	0	0	0	0	0	C: Nuclear medicine, radiation therapy, radioimmunoassays	0		
Springfield	Cameo Diagnostic Center, Inc.	0	0	0	0	0	S: Medical diagnostic			
Springfield	Interstate Nuclear Services	207	0	0	207	1.637906	P: Decontamination laundry	0	B-25 Wooden	2
Springfield	Johnson Fells, Inc.	0	0	0	0	0	SS: Thickness measurement			
Springfield	Mercy Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	0		
Springfield	Monsanto Chemical Co.	0	0	0	0	0	SS: Industrial measurement and gauging			
Springfield	Novacor Chemicals, Inc.	0	0	0	0	0	SS: Density and water level measurement			

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

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		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)				
Springfield	Springfield Department of Public Works No response to survey									
Springfield	Springfield Technical Community College	0	0	0	0	0	SS: Gas chromatography			
Westfield	Noble Hospital No response to survey									
Westfield	Springfield Municipal Water Works	0	0	0	0	0	SS: Gas chromatography			
Westfield	Tighe & Bond, Inc.	0	0	0	0	0	SS: Gas chromatography			
Hampshire County										
Amherst	Amherst College	0	0	0	0	0	R/S: Research and teaching	0		
Amherst	Univ. of MA, Amherst	120	0	0	120	0.14484	R/S: Research and teaching	0	55 Gallon Steel Drum	1
Northampton	Cooley Dickinson Hospital	0	0	0	0	0	C: Nuclear medicine Imaging	0		
Northampton	Smith College	15	0	0	15	0.019215	R/S: Research and teaching	0	55 Gallon Steel Drum	1
Northampton	V.A. Medical Center	0	0	0	0	0	SS: Medical diagnostic Imaging			
South Hadley	Mount Holyoke College	0	0	0	0	0	R/S: research and teaching	0		

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

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		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)					
Middlesex County											
Action	ENSR Consulting & Engineering No response to survey										
Arlington	Symmes Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	Storage for decay, return to supplier	0		
Ashland	Kidde-Fenwal Inc.	0.67	0	0	0.67	0.021	P: Smoke detectors		8.01	5 Gallon Pail	2
Ayer	Nashoba Community Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	Storage for decay, return to supplier	0		
Bedford	CIS-US Inc.	7.5	0	0	7.5	1.4315	P: Manufacture and distribution of radiopharmaceutical	Storage for Decay	12		1
Bedford	ENRM Veterans Hospital	45	0	0	45	4.9148	C/R: Nuclear medicine and research		0	55 Gallon and 5 Gallon Steel Drum	34
Bedford	ESA Labs, Inc.	0	0	0	0	0	SS: Gas chromatography				
Bedford	Millipore Corporation	0	0	0	0	0	R: Protein labeling	Storage for decay, return to manufacturer	45.5		
Bedford	National Environmental Testing, Atlantic, Inc.	0	0	0	0	0	SS: Gas chromatography				

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

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		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)					
Bedford	Spire Corp.	0	0	0	0	0	SS: Wear monitoring				
Billerica	Aeon Systems	0	0	0	0	0	SS: Weight measurement				
Billerica	Cambridge Medical Tech. Corp.	0	0	0	0	0	O: License terminated				
Billerica	C. R. Bard Inc., Bard Vascular Systems Division	0	0	0	0	0	O: License terminated				
Billerica	Du Pont Merck Pharmaceutical	314.3	0	0	314.3	86.00908	P: Radio-pharmaceuticals	Compaction, storage for decay	0	Type 7A Container, 55 Gallon Steel Drum	8
Billerica	E.I. Du Pont De Nemours & Co.	132.5	0	0	132.5	23.9146	P: Radio-pharmaceuticals	Compaction, storage for decay	4157	30, 55 & 85, Gallon Steel Drum & 7A Container, Poly HIC,	27
Billerica	E.I. Du Pont De Nemours & Co.	1963.5	92.5	15	2071	1758.54	P: Radio-pharmaceuticals		875	55 Gallon Steel Drum	
Billerica	Inframetrics, Inc.	0	0	0	0	0	SS: Chemical agent detector				
Billerica	MIE, Inc. No response to survey										
Burlington	Amersham Corporation	302.6	0	0	302.6	22.2368	P: radiographic sealed sources	Compaction, storage for decay	277.5	55 Gallon Drum	6
Burlington	Calibration Technology, Inc.	0	0	0	0	0	SS: Calibration sources				

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		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)				
Burlington	Lahey Clinic Medical Center	0	0	0	0	0	Storage for decay	4.8		
Burlington	Millipore Corporation	0	0	0	0	0	Storage for decay	16.1		
Burlington	M/A-Com Inc., Radar Products Operation	32.08	0	0	32.08	12.0087	P: Microwave receiver protector tubes	8	30 Gallon Steel Drum	3
Burlington	Raytheon Service	0	0	0	0	0	SS: Calibration sources			
Burlington	Scintacor, Inc.	0	0	0	0	0	SS: Calibration sources			
Burlington	Solid State Testing, Inc.	0	0	0	0	0	SS: Leak testing on semiconductors			
Burlington	Visidyne, Inc.	0	0	0	0	0	SS: Calibration sources			
Cambridge	Advanced Magnetics Inc.	381	0	0	381	0.30088	P/R: R & D of pharmaceuticals	7.5	30 & 55 Gallon Drum	12
Cambridge	Alkermes Inc.	67.5	0	0	67.5	0.0127	R: Biological Assays, pharmacokinetics in rodents, in-vitro assays in cell cultures	0	30 Gallon Drum	2
Cambridge	American Bio-Technologies Inc.	0	0	0	0	0	R: Biotech. research	5		
Cambridge	American Science & Engineering, Inc.	0	0	0	0	0	SS: Calibration sources			
Cambridge	Applied bioTechnology	15	0	0	15	0.07	R: Biotechnology research	37.5	55 Gallon Steel Drum	3

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

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		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)				
Cambridge	Arthur D. Little Inc.	15	0	0	15	0.017	R: Biochemical experiments	0	55 Gallon Steel Drum	2
Cambridge	BASF BioResearch Corp.	202.13	0	0	202.13	0.2651	R: Cancer research	0	Type A 55 Gal Steel Drum	7
Cambridge	Baxter Diagnostics No response to survey									
Cambridge	Biogen Inc.	62.5	0	0	62.5	0.155	R: Biotechnology research and development	46	55 Gallon Steel Drum	2
Cambridge	Bioran Medical Laboratory	0	0	0	0	0	S: Medical laboratory testing	0		
Cambridge	BioSurface Technology	0	0	0	0	0	R: Biological research	8		
Cambridge	Biotechnica Diagnostics, Inc.	0	0	0	0	0	O: Licansa terminated	0		
Cambridge	Cambridge Hospital	0	0	0	0	0	S: Nuclear medicine			
Cambridge	Cambridge Neuroscience Research	106	0	0	106	0.016577	R: Biological research	26.5	55 Gallon Steel Drum, 30 Gallon Steel Drum	12
Cambridge	Camp Dresser & McKee	0	0	0	0	0	SS: Analysis of environmental samples			
Cambridge	Charles Stark Draper Laboratory	0	0	0	0	0	R: Radiation hardening testing of electronics	0		
Cambridge	CytoMed Inc.	0	0	0	0	0	R: DNA labelling	11.51		

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		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)				
Cambridge	Enzytech, Inc.	52.5	0	0	52.5	0.00041	Storage for decay	15	55 Gallon Steel Drum	5
Cembridge	ERCO/Enseco	0	0	0	0	0				
Cambridge	Genetics Institute	495	0	0	495	1.463	Compaction, storage for decay	60	55 Gallon Steel Drum	12
Cambridge	Genzyme Corp.	60	0	0	60	1.2613	Storage for decay	16	55 Gallon Steel Drum	3
Cembridge	Heley & Aldrich, Inc.	0	0	0	0	0				
Cambridge	ImmuLogic Pharmaceutical Corporation	34.5	0	0	34.5	0.009146	Incineration, storage for decay	79.5	55 & 30 Gallon Steel Drum	10
Cambridge	ImmunoGen Inc.	4.5	0	0	4.5	0.000103	Storage for decay	0	30 Gallon Steel Drum	2
Cembridge	Imreg Inc.	15	0	0	15	0.01665	Sorting/segregation	0	55 Gallon Steel Drum	1
Cembridge	International Biotechnology Labs.	0	0	0	0	0	Storage for decay	9.3		
Cembridge	Maniebs, Inc.	0	0	0	0	0				
Cembridge	Matritech Inc.	0	0	0	0	0	Storage for decay	0		
Cambridge	Melpath Labs Inc.	24	0	0	24	0.00162	Return to supplier	0		1

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		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)			
Cambridge	MA Institute of Technology	570	0	0	570	25.92107	Compaction, storage for decay	30 Gallon Steel Drum	8
Cambridge	Mount Auburn Hospital	0	0	0	0	0	Return to supplier		
Cambridge	Omnigene Inc.	37.5	0	0	37.5	0.005	Inchineration, storage for decay	55 Gallon Steel Drum	2
Cambridge	Organogenesis Inc.	56.51	0	0	56.51	0.013131	Compaction, adsorption	30 & 55 Gallon Steel Drum	4
Cambridge	PharmaMar USA, Inc.	0	0	0	0	0			
Cambridge	Polaroid Corporation	0	0	0	0	0	SS: Thickness measurements		
Cambridge	Procept Inc.	19.5	0	0	19.5	0.000036	R: DNA and protein labelling	30 & 55 Gallon Steel Drum	2
Cambridge	Protein Engineering Corporation	0	0	0	0	0	R: Recombination and DNA research		
Cambridge	Repligen Inc.	114.58	0	0	114.58	0.229146	R: Biotechnology R & D	30 & 55 Gallon Steel Drum	7
Cambridge	Santa Maria Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine		
Cambridge	SEA Consultants	0	0	0	0	0	O: License terminated		
Cambridge	Somatix Corp.	0	0	0	0	0	O: License terminated		

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City	Organization	Description of Waste Shipped for Disposal					Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)					
Cambridge	T Cell Sciences	6.93	0	0	6.93	0.10635	R: R & D of pharmaceutical and diagnostic reagent	Compaction, incineration, storage for decay	0	30 & 55 Gallon Steel Drum	3
Cambridge	Transkaryotic Therapies Inc.	45	0	0	45	0.0001	C: Molecular biological probe and radioimmunoassays	Storage for decay	22.5	55 Gallon Steel Drum	1
Cambridge	TRW Fasteners Div.	0	0	0	0	0	SS: Analytical measurements				
Cambridge	U.S. DOT, Volpe Transportation Ctr.	0	0	0	0	0	SS: Gas chromatography				
Cambridge	Vertex Pharmaceutical	0	0	0	0	0	R: R & D of human pharmaceutical	Storage for decay	37.5	55 Gallon Drum	
Cambridge	Warner-Lambert Co.	0	0	0	0	0	O: License terminated				
Cambridge	Whitehead Inst. for Biomed. Research	142.5	0	0	142.5	0.252768	R: Biomedical research	Compaction & storage for decay	0	55 & 30 Gallon Steel Drum	3
Chestnut Hill	Boston College	35.3	0	0	35.3	0.07418	S/R: Teaching and research	Storage for decay	0		4
Concord	Emerson Hospital	0	0	0	0	0	C: Diagnostic services	Storage for decay	0		
Concord	Oxford Analytical	0	0	0	0	0	SS: XRF analyzers				
Concord	Nuclear Metals Inc.	10502.48	0	0	10502.48	19.273	P: Manufacture of armor piercing bullets for the A-10 ground support aircraft		0	Steel Box, 30/35 cu. ft. bags, 85 & 89 Gallon Steel Drum, 85/55 Drums, "B-25" Steel Box/55 Drum	23

**Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)**

City	Organization	Description of Waste Shipped for Disposal					Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)				
Dracut	United Circuits, Inc.	0	0	0	0	0	SS: Thickness measurement			
Everett	M&S Metals Co.	0	0	0	0	0	SS: X-Ray Analyzers			
Framingham	Avery-Dennison	0	0	0	0	0	SS: Thickness measurement	SS: Return to supplier		1
Framingham	Dositec, Inc.	0	0	0	0	0	SS: Calibration sources			
Framingham	Framingham Union Hospital	0	0	0	0	0	S: Nuclear Medicine			
Framingham	Gene-Trak Systems, Corp.	7.5	0	0	7.5	0.0202	R: R & D of DNA diagnostic products for the clinical market	Compaction, Incineration	55 Gallon Steel Drum	2
Framingham	MA Emergency Management Agency	0	0	0	0	0	SS: Training demonstrations and Instrument calibration			
Framingham	Perini Corporation No response to survey									
Holliston	Axton-Cross Co.	0	0	0	0	0	O: License terminated			
Hopkinton	Biomeasure Inc.	15	0	0	15	0.241111	R: Pharmaceutical research	Incineration, Storage for decay	55 Gallon Steel Drum & 5 Gallon Plastic Drum	4
Hopkinton	Creativa Biomolecules Inc.	42.5	0	0	42.5	0.047	R: Biotech research activities	Compaction, storage for decay	55 Gallon Steel Drum	2
Hopkinton	Liberty Mutual Insurance Co., Research Center	0	0	0	0	0	SS: Calibration sources, gas chromatography			

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal					Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)					
Hopkinton	Seragen Inc.	240	0	0	240	0.10393	R: Biological research	Compaction	52.5	55 Gallon Steel Drum	9
Hudson	Digital Equipment, Corp.	0	0	0	0	0	SS: Gas chromatography				
Lexington	Instrumentation Laboratories	0	0	0	0	0	O: License terminated	Incineration		55 Gallon Steel Drum	1
Lexington	Interneuron Pharmaceutical Inc.	8.02	0	0	8.02	0.003601	R: Drug development programs	Incineration, storage for decay	0	30 Gallon Steel Drum	1
Lexington	Kendall Co.	0	0	0	0	0	SS: Gas chromatography				
Lexington	Loral Infrared & Imaging Systems	0	0	0	0	0	SS: Tritium light sources				
Lexington	Raytheon Co.	0	0	0	0	0	O: License terminated				
Lexington	Repligen Sandoz Research Corp.	0	0	0	0	0	R: General research purposes	Storage for decay	0		
Lexington	U.S. Environmental Protection Agency	0	0	0	0	0	SS: Gas chromatography & X-ray spectrum meters				
Lexington	W.R. Grace & Co.	0	0	0	0	0	R: Biomedical experiments	Storage for decay	0		
Uttleton	Uttleton Light & Water Departments	0	0	0	0	0	SS: Gas chromatography				
Lowell	AFT/Multi-Core, Inc., Division of Datasec	0	0	0	0	0	SS: X-ray inspection device				
Lowell	Raytheon Co.	0	0	0	0	0	O: No material on-site				

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal				Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)				
Lowell	Saint John's Hospital	0	0	0	0	0	Storage for decay, return to supplier	0		
Lowell	Saint Joseph's Hospital	0	0	0	0	0	Storage for decay, return to supplier	0		
Lowell	Shawprint No response to survey						O: Registration termination in progress			
Lowell	Textron Specialty Materials	0	0	0	0	0	SS: Unknown			
Lowell	Univ. of MA, Lowell	45	0	0	45	0.026	R/S: Research and teaching	5	55 Gallon Steel Drum	2
Lowell	Lowell General Hospital	0	0	0	0	0	C: Diagnostic and therapeutic nuclear medicine	0		
Malden	Charm Sciences Inc.	5	0	0	5	0.039	P: Invitro diagnostic test kits	0.1	55 Gallon Steel Drum	4
Malden	Enzyme Center	5.5	0	0	5.5	0.034	P: Invitro diagnostic kit	15	55 Gallon Steel Drum	1
Malden	Malden Hospital	0	0	0	0	0	C: Diagnostic and therapeutic nuclear medicine	0		
Malden	Packard Paper Box, Company	0	0	0	0	0	O: Registration terminated			
Marlboro	Contraves USA, Boston Division	1	0	0	1	0.0025	P: Components for the M1A1 Tank	0.05	Strong Tight	4

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal				Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)				
Marlboro	DesignPak	0	0	0	0	0	SS: Sealed sources			
Marlborough	Marlborough Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	Storage for decay, return to supplier	0	
Marlborough	Sepracor, Inc	0	0	0	0	0	O: License terminated			
Maynard	Advacare Diagnostics, Inc.	0	0	0	0	0	C: Diagnostic nuclear medicine			
Medford	Lawrence Memorial Hosp.	0	0	0	0	0	C: Clinical nuclear medicine	Storage for decay	0	
Medford	Neil A. Gasta, CHP No response to survey									
Medford	Tufts University	37.5	0	0	37.5	0.168	R: Labels in biomedical and chemical experiments	Compaction, storage for decay	0	1
Melrose	Melrose-Wakefield Hospital	0	0	0	0	0	C: Diagnostic and therapeutic nuclear medicine	Storage for decay	0	
Natick	Conam Inspection	0	0	0	0	0	SS: Industrial radiography			
Natick	EO&G Berthold, Inc.	35	0	0	35	0.01215	O: License terminated		0	1
Natick	Enprotech Corp.	0	0	0	0	0	O: License terminated		55 & 30 Gallon Steel Drum	

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal				Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)				
Natick	Imaging Associates Inc.	0	0	0	0	0	C: Nuclear medicine: Bona and thyroid scanning	0		
Natick	Leonard Morae Hospital	0	0	0	0	0	C: Nuclear medicine Imaging	0		
Natick	Research Biochemicals Inc.						O: License terminated			
Natick	U.S. Army, Natick R&D Center	0	0	0	0	0	R: Research and development	6		
Newton	Biotechnology Development Corp.	4.01	0	0	4.01	0.000012	O: License terminated	0	30 Gallon DOT 17H	1
Newton	GZA GeoEnvironmental	0	0	0	0	0	SS: Nuclear Density Gauges			
Newton	HNU Systems, Inc.	0	0	0	0	0	SS: Gas Chromatography			
Newton	Hygela Sciences	0	0	0	0	0	R: Research of development of flyer devices			
Newton	Nuclear Medicine Associates	0	0	0	0	0	C: Nuclear medicine			
Newton	Radon Tasting Laboratory of New England	0	0	0	0	0	O: Registration terminated			
Newton Highlands	Trow Protze Consulting Engrs.	0	0	0	0	0	SS: Sealed sources within soil analysis instruments			

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
 (continued)

City	Organization	Description of Waste Shipped for Disposal				Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)				
Newton Lower Falls	Newton-Wellesley Hospital	0	0	0	0	0	Storage for decay, return to supplier	0		
Newton Upper Falls	David Gordon Associates	0	0	0	0	0	SS: Gas Chromatography	0		
Somerville	Somerville Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	0		
Somerville	Vicam	8	0	0	8	0.41	R: radioimmunoassay in food analysis	2	30 Gallon Steel Drum	1
Stoneham	C.H.E.M. Shared Services	0	0	0	0	0	SS: Depleted uranium used as shielding			
Stoneham	U T S of Mass, Inc	0	0	0	0	0	SS: Nuclear density gauge			
Stoneham	New England Memorial Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	0		
Stow	ET&L Construction Corp.	0	0	0	0	0	SS: Nuclear density gauge			
Sudbury	Medical & Scientific Enterprises	0	0	0	0	0	SS: Calibration sources			
Sudbury	Raytheon Company	4.01	0	0	4.01	0.02917	R: Electronics research and development	0.5	30 Gallon Steel Drum	1
Tewksbury	Expert Image Systems, Inc.	0	0	0	0	0	O: License termination in progress			
Waltham	Betagen Corp.	0	0	0	0	0	P: Laboratory instrumentation	0.39		

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal				Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)				
Waltham	Brandeis University	37.5	0	0	37.5	3.782	Incineration, chemical, and physical research	45	55 Gallon Steel Drum	4
Waltham	Cabot Corporation	0	0	0	0	0	O: License terminated			
Waltham	Collaborative Research Inc.	4.5	0	0	4.5	0.0515	R: Molecular biomedical research	0	Vendor Choice	4
Waltham	Digital Scintigraphics	0	0	0	0	0	SS: Calibration sources	0		
Waltham	Eunice Kennedy Shriver Center	1.8	0	0	1.8	0.002	R: Biomedical research & clinicals assays	0	55 Gallon Steel Drum	2
Waltham	Foster-Miller, Inc.	0	0	0	0	0	SS: Density Gauge			
Waltham	GTE Labs Inc.	0	0	0	0	0	SS: Industrial radiography			
Waltham	MA MDC Field Laboratory	0	0	0	0	0	O: License termination in progress			
Waltham	Panametrics	97.6	0	0	97.6	1.05216	R: R & D on radioisotope uses and instrumentation	0	No Info Given	2
Waltham	Raytheon Company	0	0	0	0	0	P: Electron tube cathodes	75		
Waltham	Raytheon Company	0	0	0	0	0	SS: Instruments			
Waltham	SmithKline Beecham Clinical Lab.	240	0	0	240	0.014	C: In-vitro diagnostic testing	0	55 Gallon Steel Drum	3
Waltham	Teledyne Engineering Svcs	0	0	0	0	0	SS: Non-destructive testing of metals			
Waltham	TGM Detectors Inc.	0	0	0	0	0	SS: Calibration sources			

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal					Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)					
Waltham	Thermo Electron Technologies Corp.	0	0	0	0	0	SS: Electron beam welding				
Waltham	TMA Skinner & Sherman Laboratories	0	0	0	0	0	S: Analysis of soil samples				
Waltham	U.S. Army Corps of Engineers No response to survey										
Waltham	Waltham/Weston Hospital	0	0	0	0	0	C: Clinical nuclear medicine	Return to supplier	4		
Watertown	Doble Engineering, Co.	0	0	0	0	0	SS: Gas Chromatography				
Watertown	Radiation Monitoring Device, Inc.	0	0	0	0	0	S: Testing response of detectors and instruments	Storage for decay	75		
Watertown	U.S. Army Materials Technology Lab.	0	0	0	0	0	R: Materials research		652.5		
Weyland	Raytheon Company	0	0	0	0	0	O: License terminated				
West Newton	MA Department of Labor & Industries	0	0	0	0	0	O: License terminated				
Westford	Courier Westford	0	0	0	0	0	SS: Storage of unused material				
Wilmington	Charles River Laboratories	0	0	0	0	0	R: Genetic research	Storage for decay	0		
Wilmington	Ion Trek Instruments	0	0	0	0	0	SS: Gas chromatography				

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal				Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)				
Wilmington	New England Pathology Services	0	0	0	0	0	Storage for decay	0		
Wilmington	Textron Defense Systems	0	0	0	0	0	SS: Sealed sources within instruments			
Winchester	GEI Consultants, Inc.	0	0	0	0	0	SS: Nuclear density gauges			
Winchester	U.S. Health & Human Services Department, FDA	7.5	0	0	7.5	0.6024	R: Research and development	0	55 Gallon Steel Drum	1
Winchester	Winchester Hospital	0	0	0	0	0	C: Clinical nuclear medicine	0		
Woburn	Analytical Answers	0	0	0	0	0	SS: X-Ray fluorescent analyzer			
Woburn	Biotechnology Management Association	0	0	0	0	0	S: Product testing of biotechnology and pharmaceutical products	0		
Woburn	BIOTEK, Inc.	7.5	0	0	7.5	0.00301	R: In-vitro experiments	10	55 Gallon Steel Drum	2
Woburn	Crystal Diagnostics, Inc.						O: License termination in progress			
Woburn	GENTEST, Corp.	0	0	0	0	0	R: Metabolism and molecular biology studies	16		
Woburn	Micro-Dynamics Inc.	16.04	0	0	16.04	0	P: Manufacture of transmitters/receive components used in microwave radar system applications	0	30 Gallon Steel Drum	2

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal				Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume	Total Activity				
Woburn	Syncor International Corp.	0	0	0	0	0	Compaction, storage for decay	466		20
Woburn	Toxikon Corporation	0	0	0	0	0	C: Toxicological testing			
Norfolk County										
Avon	T.L. Edwards, Inc. No response to survey									
Braintree	American Engineering & Testing	0	0	0	0	0	SS: Moisture and density analysis of soil and asphalt			
Braintree	Clean Harbors Analytical Services, Inc.	0	0	0	0	0	P: Laboratory analysis			
Braintree	Wollaston Alloys, Inc.	0	0	0	0	0	SS: X-Ray analyzer			
Brookline	Boston Fertility Laboratory Inc.	0	0	0	0	0	C: Diagnostic testing	0		
Brookline	Boston Imaging Group P.C.	0	0	0	0	0	C: Diagnostic testing			
Brookline	Dr. Elias Charles Dow	0	0	0	0	0	C: Thyroid treatment			
Brookline	Life Signs/Group, Inc., Boston Cardiovascular Health Center	0	0	0	0	0	S: Nuclear medicine			
Canton	CWB Associates, Inc.	0	0	0	0	0	O: License terminated			

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal				Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume	Total Activity				
Canton	Plymouth Rubber Co.	0	0	0	0	0	SS: Nuclear density gauge			
Canton	Tamfelt Inc.	0	0	0	0	0	SS: Fabric weight measurements			
East Walpole	Ciba Corning Diagnostics Corp.	1223.9	0	0	1223.9	4.99852	P: Manufacture, R&D of immunodiagnostic reagent kits	15	30 & 55 Gallon Steel Drum	9
Medfield	Ciba Corning Diagnostics Corp.	0	0	0	0	0	R: Medical diagnostic research	0		
Medfield	Strichman Medical Equipment Inc.	1	0	0	1	0.000001	P: Used in calibration testing during manufacturing operations	0		1
Millis	GAF Building Materials Corp.	0	0	0	0	0	SS: Nuclear density gauge			
Milton	Milton Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	0		
Needham	Civiltest Labs., Inc.	0	0	0	0	0	SS: Nuclear density gauge			
Needham	Glover Memorial Hospital	0	0	0	0	0	C: Medical imaging and diagnostics	0		1
Needham Heights	Abbott Biotech Inc.	60.4	0	0	60.4	0.041056	R: Biomedical Research: radiolabeling of cells, DNA sequencing analysis, radioimmunoassay	0	55 & 30 Gal Steel Drum, 30 Gallon Steel Drum	3
Needham Heights	GTE Government Sys Corp	0	0	0	0	0	SS: sealed sources			

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal					Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)					
Norfolk	Southwood Community Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	Storage for decay	0		
Norwood	Factory Mutual Research Corp.	0	0	0	0	0	SS: Industrial Radiography				
Norwood	Norwood Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	Storage for decay, return to supplier	0		
Quincy	Eastern Nazarene College No response to survey										
Quincy	Herbert V. Shuster	0	0	0	0	0	O: License terminated				
Quincy	Procter & Gamble Mfg. Co.	0	0	0	0	0	SS: Sealed sources in various instruments				
Quincy	Quincy Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	Storage for decay, return to supplier	22.5		
Randolph	Ares Advanced Technology	0	0	0	0	0	R: Radioimmunoassay, metabolic labelling	Storage for decay	0		
Randolph	Serono Laboratories	120	0	0	120	0.011	C: Quality control testing	Compaction	48	30 Gallon Steel Drum	1
South Weymouth	South Shore Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	Storage for decay, return to supplier	0		
Stoughton	Blomedical Technologies Inc.	0	0	0	0	0	P: Labelling compounds	Storage for decay	0		
Stoughton	Goddard Memorial Hospital	0	0	0	0	0	C: Diagnostic procedures				

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal				Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)			
Stoughton	R. Zoppo Co. Inc.	0	0	0	0	0	0		
Wellesley	MA Department of Public Works	0	0	0	0	0			
Wellesley	Wellesley College	0	0	0	0	0			
Westwood	Damon Clinical Lab.	0	0	0	0	0	Storage for decay		
Westwood	PB Diagnostic Systems Inc.	45	0	0	45	0.000001	Storage for decay	55 Gallon Steel Drum	3
Weymouth	Gale Associates, Inc.	0	0	0	0	0			
Wrentham	Bella Construction Corp.	0	0	0	0	0			
Plymouth County									
Bridgewater	ABC Testing, Inc.	0	0	0	0	0			
Bridgewater	Bridgewater State College	0	0	0	0	0	Storage for decay		7
Brockton	Advacora Diagnostic, Inc.	0	0	0	0	0	Storage for decay		0
Brockton	Brockton Hospital	0	0	0	0	0	Storage for decay		0
Brockton	Cardinal Cushing General Hospital	0	0	0	0	0	Storage for decay		0
Duxbury	Battelle Ocean Sciences	0	0	0	0	0	Storage for decay		

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
 (continued)

City	Organization	Description of Waste Shipped for Disposal					Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)					
Hingham	Electro Signal Lab No response to survey										
Hingham	High Vacuum Equipment	0	0	0	0	0	O: Registration terminated				
Lakeville	Ocean Spray Cranberries	0	0	0	0	0	P: Cranberry products	Return to supplier			1
Marion	Endeco, Inc.	0	0	0	0	0	SS: Used in manufacture of instruments				
Middleboro	St. Luke's Hospital of Middleboro	0	0	0	0	0	C: Diagnostic procedures				
Plymouth	Bartlett Nuclear Inc.	0	0	0	0	0	S: Decontamination & laundry services to the nuclear industry	None	7000		
Plymouth	Boston Edison	11880.9	202.1	264.8	12347.8	706.4445	P: Electric power generation	Compaction, Incineration	55.08	Steel Uner, 10/142 Poly HIC, 14/210 Poly HIC, & 14/215 Poly HIC	48
Plymouth	Jordan Hospital	0	0	0	0	0	C: Clinical nuclear medicine	Storage for decay	0		
Rochester	SEMASS Partnership	0	0	0	0	0	SS: sealed sources				
Rockland	Baker Testing Services	0	0	0	0	0	SS: Industrial radiography				
Rockland	Blomerleux Vitek Inc.	405.5	0	0	405.5	0.913	P: In-vitro diagnostic kits	None	0	55 Gallon Steel Drum	6

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
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City	Organization	Description of Waste Shipped for Disposal				Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)				
Rockland	Briggs Associates, Inc.	0	0	0	0	0				
Rockland	Nuclear Instrument	0	0	0	0	0				
Wareham	Springborn Laboratories Inc.	247.5	0	0	247.5	0.107576	Compaction	0	55 Gallon Steel Drum	3
Wareham	Tobey Hospital	0	0	0	0	0	Storage for decay, return to supplier	22.5		
Suffolk County										
Boston	Bechtel/Parsons Brinckerhoff	0	0	0	0	0				
Boston	Beth Israel Hospital	14.7	0	0	14.7	0.00996	Storage for decay	0	Type A 55 Gal Steel Drum	1
Boston	Bolton & Galanek	0	0	0	0	0				
Boston	Boston Biomedical Research Institute	0	0	0	0	0	None	0		
Boston	Boston City Hospital	193.8	0	0	193.8	0.02842	Compaction, Storage for decay	0	55 Gallon Steel Drum	11
Boston	Boston University	7.76	0	0	7.76	0.010181	Compaction, incineration, storage for decay	22.5	50 Gallon 17H, 30 Gallon Drum	5

Table 1-17
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City	Organization	Description of Waste Shipped for Disposal					Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)					
Boston	Boston University Medical Center	488.17	0	0	488.17	48.5301	C/R: Medical research, clinical procedures	Storage for decay	0		13
Boston	Brigham & Women's Hospital	51.7	0	0	51.7	0.011756	C/R: Nuclear medicine, biomedical research, clinical procedures	Storage for decay, Incineration	0	55 Gallon Steel Drum	17
Boston	Bunker Hill Community College	0	0	0	0	0	R: Teaching and research				
Boston	Carney Hospital	0	0	0	0	0	C: Clinical nuclear medicine	Storage for decay	0		
Boston	Center For Blood Research Inc.	0	0	0	0	0	R: Laboratory tracer studies	Storage for decay	22.5		
Boston	Children's Hospital	61.7	0	0	61.7	0.045118	C/R: Medical research and diagnostics	Storage for decay	0	55 Gallon Steel Drum	8
Boston	Dana-Farber Cancer Institute	21.9	0	0	21.9	0.06511	C/R: Biomedical end cancer research, diagnosis and therapy	Incineration, storage for decay, compaction	0	55 Gallon Steel Drum	17
Boston	David C. Sproglis	0	0	0	0	0	O: License terminated				
Boston	Dr. Carl E. Cesslody	0	0	0	0	0	C: Thyroid therapy				
Boston	E.I. Du Pont De Nemours & Co.	2925.8	90	0	3015.8	29811.42	P: Manufacturer of radiopharmaceutical	Compaction, storage for decay	0	55 & 30 Gallon Steel Drums, 400 Liter HIC, & Steel Cask	3
Boston	Faulkner Hospital	0		0	0	0	C: Medical imaging and diagnostics	Storage for decay	0		
Boston	Forsyth Deniel Center	0	0	0	0	0	R: Biomedical research	Incineration, Storage for decay	7.5		2

**Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)**

City	Organization	Description of Waste Shipped for Disposal				Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)				
Boston	Harvard University	79.5	0	0	79.5	0.089528	Inclination, Compaction	0	55 Gallon Steel Drum	6
Boston	Institute of Molecular Biology	45	0	0	45	0.0242	R: Cell culture and process purification labeling	0	55 Gallon Steel Drum	5
Boston	Joslin Diabetes Center	12.1	0	0	12.1	0.004	C/R: Biomedical research and clinical assays	4.8	55 Gallon Steel Drum	2
Boston	Kupferman & Weber	0	0	0	0	0	O: License terminated			
Boston	MA Department of Public Health No response to survey									
Boston	Massachusetts Eye & Ear Infirmary	0.5	0	0	0.5	0.000001	R: Medical research for investigation of ophthalmology and otolaryngology diseases	0	55 Gallon Steel Drum	1
Boston	Massachusetts Port Authority	0	0	0	0	0	SS: Nuclear density gauge			
Boston	Mass. College Of Pharmacy/AHS	0	0	0	0	0	S/R: Teaching and research in radiopharmaceuticals	0		
Boston	MSPCA Angell Memorial Animal Hospital	0	0	0	0	0	S: Veterinarian hospital			
Boston	Museum of Fine Arts	0	0	0	0	0	SS: Analysis of papers and documents			

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal				Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)				
Boston	New England Aquarium	0	0	0	0	0		1.1		
Boston	New England Baptist Hospital	0	0	0	0	0	Storage for decay	0		
Boston	New England Deaconess Hospital	320.2	1.38	0	321.56	1.459712	C/R: Nuclear medicine and research	0	85, 55 & 30 Gallon Steel Drum	18
Boston	New England Medical Center	198.8	0	0	198.8	18.21045	C/R: Nuclear medicine and biological research	0	55 Gallon Steel Drum	9
Boston	P.X. Engineering Company	0	0	0	0	0	SS: Sealed sources			
Boston	Simmons College	0	0	0	0	0	R: Biological research	7.5		
Boston	Spaulding Rehabilitation Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	13482		
Boston	Stone & Webster Engineering Corp.	0	0	0	0	0	SS: Radiography			
Boston	St. Elizabeth's Hospital No response to survey									
Boston	Suffolk University	0	0	0	0	0	SS: Teaching and research			
Boston	The Gillette Company Tolertries Tech Lab	0	0	0	0	0	R: R & D of toiletry products	1.2		

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
 (continued)

City	Organization	Description of Waste Shipped for Disposal					Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)					
Boston	U.S. DOT, U.S. Coast Guard	0	0	0	0	0	SS: Contraband detector				
Boston	Univ. of MA, Boston	30	0	0	30	0.00099	R/S: Research and teaching	Storage for decay	0	55 Gallon Steel Drum	1
Boston	U.S.D.A., Human Nutrition Research Center	47.9	0	0	47.9	0.067241	R: Biomedical research	Compaction, Incineration	0	55 Gallon Steel Drum	8
Boston	Massachusetts General Hospital	37.3	0	0	37.3	0.005061	C: Diagnostic nuclear medicine and research	Compaction, storage for decay	288.72	55 Gallon Steel Drum	5
Boston	Nissin Molecular Biology Institute	9	0	0	9	0.0041	R: DNA sequencing	Compaction, Incineration, storage for decay	0	Steel Drum	3
Boston	Northeastern University	24,108	0	0	24,108	1.396	R/S: Research and teaching	Compaction, Incineration, storage for decay	0	30 Gallon Steel Drum	
Boston	The Eye Research Institute of Retina Foundation	0.8	0	0	0.8	0.00001	R: Biomedical research	Incineration, storage for decay	0	55 Gallon Steel Drum	1
Boston	Tufts University School of Medicine	231.25	0	0	231.25	0.36777	R: Biomedical research	Compaction, Incineration	0	55 Gallon Steel Drum	12
Boston	V.A. Medical Center	7.6	0	0	7.6	0.00093	C: Clinical nuclear medicine and laboratory studies	Compaction, Incineration, & storage for decay	22.5	55 Gallon Steel Drum	1

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal					Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)					
Dedham	American Red Cross Blood Services	0	0	0	0	0	C: Analysis to determine matching for bone marrow transplanting	Storage for decay	0.15		
Dorchester	MA Bay Transportation Authority	0	0	0	0	0	SS: Nuclear density gauge				
Dorchester	St. Margaret's Hospital for Women	0	0	0	0	0	C: Diagnostic procedures				
Everett	Whidden Memorial Hospital	0	0	0	0	0	C: Clinical nuclear medicine	Storage for decay	0		
West Roxbury	V.A. Medical Center	0	0	0	0	0	C: Clinical nuclear medicine, and biomedical research	Compaction, incineration, storage for decay	0		3
Winthrop	Winthrop Hospital	0	0	0	0	0	C: Clinical nuclear medicine	Storage for decay	32		
Worcester County											
Auburn	Cullinan Engineering Co., Inc.	0	0	0	0	0	SS: Nuclear density gauge				
Berre	Northeast Consultants, Inc.	0	0	0	0	0	SS: Nuclear Density Gauge				
Clinton	LFE Corp.	0	0	0	0	0	SS: Industrial radiation gauges				
Fitchburg	Fitchburg State College	0	0	0	0	0	R: Research and positron annihilation spectroscopy		7.5		

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal				Product/Service Information (see codes at and of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)				
Fitchburg	Burbank Hospital	0	0	0	0	0	Storage for decay	0		
Fitchburg	Dr. Robert L. McAuley, Pathologist	0	0	0	0	0	O: License terminated			
Gardner	Henry Heywood Memorial Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	0		
Holden	The Medical Center of Central MA	0	0	0	0	0	C: Medical diagnostic procedure			
Leominster	Leominster Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	0		
Millford	Center for Diagnostic Products No response to survey									
Millford	Millford-Whitinsville Regional Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	45.5		
Millford	Millipore Corp.	0	0	0	0	0	O: License terminated			
North Grafton	Wyman-Gordan Company	0	0	0	0	0	SS: Gas chromatography			
Paxton	Anna Maria College	0	0	0	0	0	R: Research and teaching			
Shrewsbury	Biohybrid Technologies	0	0	0	0	0	C: Radioimmunoassay procedures	0		
Shrewsbury	Digital Equipment Corporation	0	0	0	0	0	SS: Gas chromatography	0		1

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
(continued)

City	Organization	Description of Waste Shipped for Disposal					Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)					
Shrewsbury	Worcester Foundation For Experimental Biology	30	0	0	30	1.32	R: Biomedical teaching and research	Storage for decay	184	55 Gallon Steel Drum	2
Southbridge	Harrington Memorial Hospital No response to survey										
West Boylston	MA Materials Research, Inc.	0	0	0	0	0	SS: Industrial radiography				
Westborough	Alpha Analytical Laboratories, Inc.	0	0	0	0	0	SS: EPA performance evaluation testing				
Westborough	Haller Testing Labs of MA, Inc.	0	0	0	0	0	SS: Measurement of material density				
Worcester	Amira Inc.	0	0	0	0	0	R: DNA synthesis	Storage for decay	0		
Worcester	Cambridge Biotech Corporation	15	0	0	15	0.058664	R: DNA research	Storage for decay	.5	55 & 30 Gallon Steel Drum	2
Worcester	Clark University	0	0	0	0	0	R: Biological and physical research	Storage for decay	0		0
Worcester	College Of The Holy Cross	0	0	0	0	0	R/S: Biological experimentation for teaching and research	Storage for decay	0		
Worcester	Dr. Richard J. Broggi	0	0	0	0	0	O: License terminated				
Worcester	Hybridon, Inc.	0	0	0	0	0	R: Biomedical research	Storage for decay	15		
Worcester	Professional Service Industries, Inc.	0	0	0	0	0	SS: sealed sources				

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
 (continued)

City	Organization	Description of Waste Shipped for Disposal					Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)					
Worcester	Saint Vincent Hospital	0	0	0	0	0	C: Diagnostic nuclear medicine	Storage for decay, return to supplier	52.5		
Worcester	Saltsky Alloys, Inc.	0	0	0	0	0	SS: Metal testing				
Worcester	The Medical Center Of Central Massachusetts	0	0	0	0	0	C: Diagnostic nuclear medicine	Return to supplier	17		
Worcester	The Medical Center Of Massachusetts	0	0	0	0	0	C: Diagnostic nuclear medicine and research	Storage for decay, return to supplier	0		
Worcester	TSI Mason Research Institute	48	0	0	48	0.000044	R: Development and performance of RIA procedures	Compaction, Incineration, storage for decay	89.6	55 Gallon Steel Drum	3
Worcester	Universal Metal Corporation	0	0	0	0	0	SS: Non-destructive metal				
Worcester	University Of MA Medical Center	7.5	0	0	7.5	2.7	C: Patient diagnosis and treatment	Storage for decay	93.5	55 Gallon Steel Drum	1
Worcester	Wira & Metal Separation Systems, Inc	0	0	0	0	0	SS: Metal analysis				
Worcester	Worcester City Hospital	0	0	0	0	0	O: License terminated				
Worcester	Worcester Department of Public Health	0	0	0	0	0	SS: Gas chromatography				
Worcester	Worcester Polytechnic Institute	0	0	0	0	0	S/R: Teaching and research	Storage for decay	21.0		

Table 1-17
Inventory of Massachusetts Radioactive Materials Licensees and Registrants
 (continued)

City	Organization	Description of Waste Shipped for Disposal					Product/Service Information (see codes at end of table)	Reported Source/Waste Volume Reduction	Total Waste Stored On-Site	Shipping Containers	Number of Shipments
		Class A	Class B	Class C	Total Volume (cu. ft.)	Total Activity (curies)					
Worcester	Yankee Engineering & Testing Inc.	0	0	0	0	0	SS: Measurement of soil and pavement density.				
Totals		41,780	386	520	42,686	32,530			29,084		

P = Product; S = Service; R = Research; C = Clinical Procedures; and O = Other

The column showing "reported source/waste volume reduction is blank in those areas where the licensee uses only sealed sources. Some generators that shipped for disposal did not report using any volume reduction methods.

"Total Waste Stored On-Site" Includes waste in storage for future off-site disposal and does not include waste being treated by storage for decay.

"Number of Shipments" refers to all radioactive waste shipments as reported by the generator and includes shipments to brokers, processors, directly to a disposal site, or waste being returned to a supplier.

